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Record of Decision
Groundwater Operable Unit
Groundwater Basewide Monitoring Program

Wright-Patterson Air Force Base
88th Air Base Wing
Office of Environmental Management

Environmental Management
Wright-Patterson AFB

September 8, 1999

RECORD OF DECISION
FOR THE GROUNDWATER OPERABLE UNIT AT
WRIGHT-PATTERSON AIR FORCE BASE

Wright-Patterson Air Force Base
88th Air Base Wing
Office of Environmental Management
Wright-Patterson Air Force Base, Ohio

September 8, 1999

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ABBREVIATIONS

AOC	Administrative Orders on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
AFMC	Air Force Materiel Command
ATSDR	Agency for Toxic Substances and Disease Registry
BMP	Basewide Monitoring Program
CCRA	Current Conditions Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Contaminant of Potential Concern
EcoRA	Ecological Risk Assessment
EE/CA	Engineering Evaluation/Cost Analysis
FAA	Further Action Area
FS	Feasibility Study
FCRA	Future Conditions Human Health Risk Assessment
GWOU	Groundwater Operable Unit
gpm	gallons per minute
HI	Hazard Index
HQ	Hazard Quotient
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCE	Perchloroethylene or Tetrachloroethylene
PELP	Potential Exposure Location Point
PW	Present Worth
RA	Remedial Action
RD	Remedial Design
RAO	Removal Action Objective
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Site Investigation
TCE	Trichloroethylene
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV/OX	Ultraviolet/Oxidation
VOC	Volatile Organic Compound
WPAFB	Wright-Patterson Air Force Base

I THE DECLARATION

1.0 Site Name and Location

This Record of Decision (ROD) addresses the findings of investigations at Installation Restoration Program (IRP) Sites OT069 and OT070 (also known as the Groundwater Operable Unit [GWOU]) at Wright-Patterson Air Force Base (WPAFB). WPAFB is located in Greene and Montgomery Counties, Ohio.

2.0 Statement of Basis and Purpose

This decision document presents the rationale for the selected remedial alternative for the GWOU at WPAFB. The selection process was conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The United States Air Force (USAF) is the lead agency for WPAFB with the U.S. Environmental Protection Agency (USEPA) and the Ohio EPA (OEPA) as support agencies. The lead agency, USAF, along with the support agencies, USEPA and OEPA, recommend the selected alternative for the GWOU. This decision is based on the Administrative Record for WPAFB.

3.0 Assessment of the Site

The USAF has determined that actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. These risks will be addressed by implementing the recommendations presented in this ROD.

4.0 Description of the Selected Remedy

This ROD presents the selected remedy for the GWOU at WPAFB. This ROD is the sixth and final ROD for sites at WPAFB. Previous RODs have addressed sources of contamination at identified Operable Units (OUs) and individual sites within those OUs. The selected remedy addresses the principal threats posed by groundwater at WPAFB by treating the most highly contaminated areas of groundwater and those areas of contaminated groundwater most likely to migrate off-site.

The selected remedy for the GWOU at WPAFB is:

- Continue current groundwater extraction, treatment and discharge at the WPAFB property boundary in OU5 and continue long-term monitoring in this area. This area has been termed "Further Action Area A".

- In-situ chemical oxidation in the area near Spill Site 11 and monitoring. This area has been termed "Further Action Area B".

- Long-term monitoring for the remainder of the GWOU. Those areas to be monitored are:

  – Areas that exceed Maximum Contaminant Levels (MCLs) for organic contaminants of potential concern (COPCs), but do not exceed the target risk range of $1x10^{-4}$ to $1x10^{-6}$.
  – Areas that exceed a cumulative cancer risk of $1x10^{-4}$ or a Hazard Index of 1 for organic COPCs, but do not exceed MCLs.
  – Areas exceeding remediation goals (MCLs or background) for inorganic COPCs.
  – Areas with existing remedies in place (OU1 and OU2).

- Access restrictions to limit access to groundwater. The bulk of the GWOU is located within an active military installation with limited access. This access restriction is applicable to the installation of private wells and new public water supply well fields. Public water supply wells will require approval from the State of Ohio prior to installation. WPAFB, as an active military installation, will control the installation of private wells.

- No action for surface water and sediment. Surface water will continue to be monitored in accordance with WPAFB's National Pollutant Discharge Elimination System (NPDES) permit for stormwater.

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The selected remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

5.0 Data Certification Checklist

The following information is included in Section II - Decision Summary of this ROD:

- COPCs and their respective concentrations
- Baseline risk represented by the COPCs
- Cleanup levels established for COPCs and the basis for these levels
- Current and future land and groundwater use assumptions used in the baseline risk assessment and ROD
- Land and groundwater use that will be available at the site as a result of the Selected Remedy
- Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected
- Decisive factor(s) that led to the remedy selection.

Additional information can be found in the Administrative Record file for this site.

Declaration Statement
United States Air Force – Air Force Materiel Command

Based on the evaluation of analytical data and other information, the United States Air Force has determined that the selected remedy is necessary to ensure protection of human health and the environment at these sites. The selected remedy meets Applicable or Relevant and Appropriate Requirements (ARARs) established by federal, state, or local environmental laws. The selected remedy is cost effective, and uses permanent solutions and alternative treatment technologies to the extent practicable. The selected remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). In accordance with NCP Section 300.430 (f)(4)(ii), a review will be conducted within five years after finalization of this Record of Decision to ensure that this decision provides continued protection of human health and the environment.

Stewart E. Cranston

STEWART E. CRANSTON
Lieutenant General, USAF
Vice Commander

29 Sep 1999
Date

Declaration Statement
United States Environmental Protection Agency

Based on the evaluation of analytical data and other information, the United States Environmental Protection Agency has determined that the selected remedy is necessary to ensure protection of human health and the environment at these sites. The selected remedy meets Applicable or Relevant and Appropriate Requirements (ARARs) established by federal, state, or local environmental laws. The selected remedy is cost effective, and uses permanent solutions and alternative treatment technologies to the extent practicable. The selected remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). In accordance with NCP Section 300.430 (f)(4)(ii), a review will be conducted within five years after finalization of this Record of Decision to ensure that this decision provides continued protection of human health and the environment.

Wm. E. Muno

William E. Muno
Director, Superfund Division
U.S. Environmental Protection Agency Region V

9/29/99
Date

Declaration Statement
Ohio Environmental Protection Agency

Based on the evaluation of analytical data and other information, the Ohio Environmental Protection Agency has determined that selected remedy is necessary to ensure protection of human health and the environment at these sites. The selected remedy meets ARARs established by federal, state, or local environmental laws. The selected remedy is cost effective, and uses permanent solutions and alternative treatment technologies to the extent practicable. The selected remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). In accordance with NCP Section 300.430 (f)(4)(ii), a review will be conducted within five years after finalization of this Record of Decision to ensure that this decision provides continued protection of human health and the environment.

Christopher Jones
Director, Ohio Environmental Protection Agency

9-30-99
Date

II DECISION SUMMARY

1.0 Site Name, Location, and Description

WPAFB is located in southwestern Ohio, about ten miles northeast of the City of Dayton and southwest of the City of Fairborn (see Figure 1). The Base occupies approximately 8,500 acres of Greene and Montgomery Counties, immediately adjacent to Clark County. WPAFB is headquarters for the Air Force Materiel Command (AFMC), which is involved in many national defense activities including research and development, flight testing, and maintenance of Air Force weapons systems.

1.1 Site Location and Description

The Base is divided into three administrative areas: A, B, and C (Figure 2). Areas A and C surround Patterson Field, an active USAF airfield. Area B is located southwest of Areas A and C and contains Wright Field, an inactive airfield. WPAFB employs approximately 24,000 civilian and military personnel.

Areas A and C, and Area B are separated by State Route 444 and ConRail Corporation railroad tracks. Areas A and C encompass 5,711 acres. Area A is primarily comprised of building complexes and Area C is primarily comprised of active runways and flight facilities. Current and historical operations that have occurred in Areas A and C include:

- Aircraft and vehicle fueling
- Aircraft and vehicle maintenance
- Runway and aircraft deicing
- Munitions and explosive ordnance disposal
- Warehousing and storage
- Small arms training
- Steam and electrical generation
- General site maintenance (roads, mowing, etc.)
- Miscellaneous disposal
- Office operations and classroom instruction.

Area B encompasses approximately 2,800 acres and contains a complex of buildings and three runways that are no longer utilized for flying except occasionally when aircraft are flown in for exhibition at the Air Force Museum. Current and historical operations are oriented more toward industrial usage in general and research and development in particular.

This Record of Decision (ROD) document refers to the GWOU. The GWOU is comprised of the groundwater beneath WPAFB and areas affected by off-site migration of contaminants from WPAFB. Surface water was also included in the GWOU. The GWOU does not include unsaturated soils within current IRP site boundaries because unsaturated soil was part of each source OU. The source OUs have been addressed in previous RODs and other decision documents.

1.2 Geologic and Hydrogeologic Description

Geologically, WPAFB is located within the till plains section of the central lowlands physiographic province. The land surface of the region is generally flat to gently rolling with streams and rivers forming level flood plains. Topographic relief in the area of WPAFB is the result of glacial deposition activity from the Wisconsin glaciation of the Pleistocene Age. Land surface elevations range from approximately 950 feet (ft) on top of the ridge in the southern portion of Area B to approximately 790 ft along Springfield Street in the northern portion of Area B.

WPAFB and the present day Mad River overlie a buried Pleistocene valley. Bedrock underlying WPAFB consists primarily of fine-grained, soft, calcareous, fissile shale with thin beds of limestone deposited during Late Ordovician time. Area B overlies a bedrock ridge in the eastern portion of the Area and a deep stage valley to the west. The bedrock ridge extends north and south from Huffman Dam through Area B toward the southeast. The remainder of Area B overlays Richmondian Shale.

The bedrock valley in the region is filled with unconsolidated valley train type sediments consisting of glacial outwash, glacial till layers, and modern alluvial deposits. Valley train deposits consist predominantly of sand and pebble gravel mixtures with local discontinuous silt and clay layers.

Hydraulically, WPAFB is located within the Mad River valley of the Great Miami River Basin. The Mad River empties into the Great Miami River near downtown Dayton, OH, approximately three miles downstream (southwest) of the site. Several surface water bodies are located within the WPAFB and include Hebble and Trout Creek, Bass, Twin and Gravel Lakes, an unnamed lake adjacent to Huffman Dam, drainage ditches located adjacent to roads, and wetlands.

Groundwater at the site is defined as part of the Mad River Aquifer, which is part of the Miami Buried Valley Aquifer, a sole source aquifer. The Buried Valley Aquifer is a prolific source of water and is highly utilized as a municipal and industrial source. Groundwater extraction in the vicinity of WPAFB occurs at the City of Dayton’s Huffman Dam wellfield and the Rohrer's Island wellfield; two City of Fairborn wellfields; the WPAFB Springfield Street, Skeel Road, and Water Road wellfields; Wright-State University; and the southwest boundary line of the groundwater removal action currently active on WPAFB.

The Buried Valley Aquifer within the area is a designated sole source aquifer under Section 1424(e) of the SDWA and the Ohio Administrative Code (OAC) Rule 3745-27-07(B)(5). The aquifer is generally confined to the buried valleys. Groundwater is recharged through infiltration of precipitation, groundwater flow into the area, and infiltration of surface water. Groundwater discharges from the area include groundwater flow out of the area; evapotranspiration from lakes, wetlands, and vegetated areas; groundwater extraction at numerous wellfields; and discharge into the Mad River.

2.0 Site History and Enforcement Activities

In February 1988, WPAFB and the Ohio Environmental Protection Agency (OEPA) signed Administrative Orders on Consent (AOC) pursuant to Ohio Revised Code (ORC) Sections 3734.13, 3734.20, and 6111.03. The AOC specifies the requirements for conducting preliminary assessments (PAs), site investigations (SIs), remedial investigations (RIs), feasibility studies (FSs), remedial designs (RDs), and remedial actions (RAs) at the Base. These activities were conducted under the Installation Restoration Program (IRP), which is an element of the Defense Environmental Restoration Program (DERP) and is concurrent with the guidelines and standards set forth in the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA). The overall objective of the USAF IRP is to identify, investigate, and remedy all environmental contamination problems resulting from past hazardous waste disposal practices at USAF installations. WPAFB has entered into agreements with the OEPA and the United States Environmental Protection Agency (USEPA) Region V regarding conduct of IRP activities at the Base.

After the USEPA listed WPAFB as a National Priorities List (NPL) site in October 1989 (bringing it into the Federal Facility Provision of CERCLA §120), WPAFB entered into a Federal Facility Agreement (FFA) with the USEPA that establishes a procedural framework and schedule for implementing and monitoring response actions at the Base. This FFA was signed in March 1991 pursuant to the following authorities:

- CERCLA §120
- Sections 6001, 3008(h), 3006, and 3004(u) and (v) of the Resource Conservation and Recovery Act (RCRA), as amended
- DERP.

The FFA requires compliance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), CERCLA guidance and policy, RCRA guidance and policy, and applicable state law.

As part of the IRP, an RI/FS Work Plan was developed for 39 potential waste disposal sites. Twenty-six other sites were also identified and incorporated into the IRP. These sites were grouped into 11 geographically-based source operable units (designated OUs 1 through 11) and one groundwater operable unit (IRP site OT059). In September 1997, two additional IRP sites were established: one for groundwater in Areas A and C (IRP site OT069) and one for groundwater in Area B (IRP site OT070). With the establishment of IRP sites OT069 and OT070, IRP site OT059 was administratively closed out. IRP sites OT069 and OT070 collectively constitute the GWOU. The decision for no further action or to implement source control measures at the 64 IRP sites has been documented in five RODs previously signed for the base. This ROD constitutes the sixth ROD for WPAFB.

3.0 Highlights of Community Participation

WPAFB currently has an Environmental Advisory Board composed of representatives from local government agencies, businesses, and the community groups that actively play a role in the WPAFB IRP process. The group meets quarterly to discuss and concur on a variety of topics related to the environmental program at WPAFB. The group also has the opportunity to review and comment on all documents addressing the IRP sites.

WPAFB offered an opportunity for public input and community participation during the Proposed Plan for the GWOU. The Proposed Plan was made available to the public in both the Administrative Record and the Information Repository. The Administrative Record is located in the Archives Section (4^{th} Floor), of the Paul Laurence Dunbar Library at Wright State University and the Information Repository is located in the Greene County Library, Fairborn Branch, both located in Fairborn, Ohio. The notice of availability for the Proposed Plan was published in the Dayton Daily News (local paper) on August 1, 1999 and in The Skywrighter (Base newspaper) on August 6, 1999. A public comment period was held from August 2, 1999 to August 31, 1999. The public comment period was not extended as there were no requests for an extension. The Base held a public meeting on August 9, 1999 at the Greene County Library, Fairborn Branch to discuss the investigatory activities that took place at the GWOU. Representatives from the USEPA, OEPA and WPAFB were present to answer questions about the Base and the GWOU; however, no questions were asked. This is specified in Responsiveness Summary (Section III) of this ROD.

4.0 Scope and Role of Response Action Within Site Strategy

WPAFB previously grouped the confirmed or suspected IRP sites into 11 source OUs and one groundwater OU. Remedies for 64 IRP sites from the 11 source OUs, plus three additional non-IRP sites, have been included in previous Records of Decision (RODs). Source control measures were implemented because successful remediation of groundwater depends on removing sources of contamination. WPAFB has undertaken a streamlined cleanup approach in which: 1) sites that did not require remediation were identified and closed with no further action; 2) sites that required remediation were addressed by non-time-critical removal actions (these removal actions occurred primarily at landfills); or 3) other remedial actions were performed (e.g., at OU1 and OU2). For example, WPAFB initiated removal actions in the groundwater plume at OU5 and in the OU2 petroleum hydrocarbon plume to address groundwater contamination.

The decision for no further action or to implement source control measures at the 64 IRP sites has been documented in five RODs previously signed for the base. These RODs are: 1) OU1 Source Control Operable Unit ROD; 2) OU1 Off-Source ROD; 3) a ROD for three sites in OU2; 4) a ROD for 21 sites throughout the base; and, 5) a ROD for 41 sites throughout the base. Information regarding site history, alternatives evaluated for remediation, and/or justification for no further action can be found for the 64 sites in the five RODs.

Investigations conducted at the source OUs indicated the presence of several groundwater contaminants in various locations throughout the Base. These contaminants, primarily volatile organic compounds (VOCs), occur both as definable plumes and as isolated occurrences. Because of groundwater movement under the Base and surface water through the Base, contaminants may be transported from one area to others, co-mingling contaminants, and finally moving into remote portions of the Base. Therefore, groundwater, surface water, and sediment contaminants from each of the 11 source OUs and groundwater contaminants that were not attributable to a known source on the Base were combined to form the GWOU for removal activities under the Basewide Monitoring Plan (BMP). The purpose of the BMP was to evaluate this contaminant movement, assess the risks posed to human health and the environment by exposure to the contaminants, and design a remedy for groundwater, surface water and sediment throughout the Base (if necessary).

This ROD refers to the GWOU. The upper and lower boundaries of the GWOU are the water table surface and the top of bedrock at the base of the alluvial aquifer. The GWOU is limited to the Buried Valley Alluvial Sole Source Aquifer, as defined under Section 1425(e) of the Safe Drinking Water Act (SDWA). However, surface water was included in the GWOU because surface water at WPAFB presents similar issues as groundwater. The GWOU did not include unsaturated soils within current IRP site boundaries because unsaturated soil is part of each source OU. The horizontal boundary of the GWOU is limited to the confines of the Base boundary and areas affected by off-site migration of contaminants from WPAFB.

5.0 Summary of Site Characteristics

Although a large body of data existed from previous investigations conducted at the various OUs and from regional contaminant hydrogeologic studies, a field investigation was also conducted for the GWOU to fill critical data gaps. Data from the field investigation, along with historical data collected from various OU investigations, were used to support four primary data analysis tasks conducted for the BMP. These tasks were:

- Prepare a groundwater flow model
- Develop a groundwater contaminant transport model
- Conduct a risk assessment based on current conditions
- Conduct a risk assessment based on projected future conditions.

WPAFB is currently an active Air Force Base with the land use being activities associated with maintaining military aircraft, vehicles, and ammunition. These activities are primarily conducted in Areas A and C. There are also several research and development activities conducted primarily in Area B. WPAFB is scheduled to continue operating as an active Air Force Base and projected future land use is likely to remain the same as it is today.

The flow and contaminant transport model results are discussed below. The risk assessment results are discussed later in Section 6 of this document.

Flow Modeling

A three-dimensional groundwater flow model was developed using MODFLOW, a United States Geological Survey (USGS) mathematical model, to determine groundwater flow direction and velocity at WPAFB. The flow model was developed for an area of about 9.64 miles by 4.32 miles, centered on WPAFB. The results of the flow model were used as input into the groundwater contaminant transport model. This flow model indicates that groundwater flow within the model area is controlled by the size and shape of buried valleys. Flow underneath WPAFB Areas A and C is southwesterly along a main valley underlying the Mad River, and northerly along tributary valleys that join the main valley under Area C. The valley narrows near Huffman Dam, constricting groundwater flow and causing an increase in groundwater velocity. This area is marked by high groundwater flows and discharge to the Mad River. Downgradient of Huffman Dam, the valley widens and is joined by another tributary valley. The City of Dayton's Rohrer's Island Wellfield is located near the confluence of these two valleys. Groundwater flow downgradient of Rohrer's Island follows the valley, which trends to the west in that area.

Contaminant Transport Modeling

Following completion of the flow model, three-dimensional transport modeling of COPCs was conducted to predict contaminant concentrations at 30, 60, and 90 years in the future. These results were then used in a future conditions risk assessment to estimate the risk to human health from exposure to groundwater at these time intervals. All transport predictions were completed using the MT3D code. Results of the transport model showed that the maximum concentration of all organic COPCs would be less than 1 µg/L after 30 years with the following exceptions:

- Trichloroethylene (TCE) at OU5, OU4, and OU1 (TCE concentrations at OU4 would be below 1 µg/L within 65 years)
- Perchloroethylene (PCE) at OU5
- Vinyl chloride at OU1 and the area near Spill Site 11
- Benzene at UST71A and OU2 (current monitoring results, however, indicate that benzene concentrations are nondetect at UST71A and have been significantly reduced at OU2).

The transport model indicated little or no perceivable migration of inorganic COPCs over the 90-year period modeled.

The predictions of the transport model are borne out by recent rounds of groundwater sampling that have consistently shown declining concentration of organic COPCs (in comparison to concentrations detected 10 years ago). The monitoring data also show that the groundwater plumes associated with organic COPCs are not expanding, and, in fact, most are decreasing n size with several areas now showing non-detectable levels of organic COPCs in groundwater.

This can be attributed to both, natural process and actions taken by WPAFB in controlling sources and remediating plumes. Plumes naturally tend to stop expanding because the natural processes, such as dispersion and dilution due to groundwater flow and biological activity, tend to limit the size of plumes after some years. Source control measures at WPAFB have included actions taken at OU5 (landfill cap and groundwater extraction/treatment), OU1 (landfill cap and leachate control), and OU8 (bioslurping).

6.0 Summary of Site Risks

Groundwater contamination data collected by WPAFB since 1982 were evaluated to determine the potential to affect human health. Contamination in surface water bodies and associated sediment were also evaluated to determine the potential to affect plants and animals. Human health effects from chemicals in surface water and sediment were evaluated previously during investigations conducted for the individual OUs.

A Current Conditions Human Health Risk Assessment (CCRA) was conducted to provide estimates of potential current human health risk associated with exposures to the groundwater. The CCRA used groundwater data collected by WPAFB since 1982 to assess potential human health risk. Potential future risks to human health (resulting from the movement of groundwater) and the ecological risk assessment of surface water and sediment, were evaluated in the Future Conditions Human Health Risk Assessment (FCRA), and in the Basewide Ecological Risk Assessment (EcoRA), respectively

6.1 Groundwater Human Health Risk

The human health risk assessments (both the CCRA and the FCRA) evaluated potential exposure to three populations: off-Base residents, on-Base residents, and on-Base workers. The FCRA also evaluated changes in risk over time as contaminant concentrations changed. The following twenty-five COPCs were identified in the GWOU:

- Eleven organics: benzene, 1,2-dichloroethane, 1,2 dichloroethene, ethylbenzene, toluene, TCE, PCE, vinyl chloride, xylene, DDT, and octachlorodibenzo-p-dioxin; and

- Fourteen inorganics: aluminum, antimony, arsenic, barium, chromium, cobalt, copper, lead, manganese, nickel, selenium, thallium, vanadium, and zinc.

The COPCs were selected using background concentrations, detection frequency, essential nutrient status, and toxicity. As a conservative measure, risk was estimated for all COPCs, except lead, both individually and collectively to determine the total contribution for all COPCs to potential human health risk. Risk was evaluated separately for lead.

Each potentially exposed population (off-Base residents, on-Base residents, and on-Base workers) was estimated for risk under various scenarios. The greatest risk was found to be to the off-Base resident from chemicals in the uppermost layer of the aquifer, because of higher exposure duration estimates and the potential number of pathways. Therefore, for simplicity, this is the only risk estimate discussed in this document. Risk to this population is discussed relative to USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ for carcinogens and a hazard index (HI) of 1 for noncarcinogens. A cancer risk level of $1x10^{-6}$ to $1x10^{-4}$ for an exposed population means that one additional person out of between one million to a hundred thousand persons is at some additional risk for developing cancer. A HI of 1 implies that exposure to chemicals of concern exceeds the protective level for those chemicals. Results of estimates from other receptors and other aquifer layers can be found in the CCRA and FCRA.

6.1.1 Current Conditions Risk Assessment (CCRA)

Numerical risk estimates were calculated for ten potential exposure location points (PELPs) in Areas A and C and six PELPs in Area B. The PELPs are theoretical locations based on modeled estimates of areas where selected plumes crossed the Base boundary and where supply wells are currently located. As an example, Figure 3 shows that the carcinogenic risk for organic contamination is above $1x10^{-4}$ for potential off-Base residential exposures at the boundary of OU5 because of the presence of PCE and TCE. Noncarcinogenic hazard associated with all COPCs for off-Base residential exposures exceeds the target HI of 1 west of OU3, east of OUs 2 and 10, and south of OU9. (Maps of noncarcinogenic hazard are not presented here, but are available in the CCRA). Arsenic is found to exceed the target range east of OU7 and northeast of OU10; however, arsenic is below the maximum contaminant level (MCL) at these locations. Manganese and arsenic plumes are found north of OU6, west of OU5, north of OU11, and east of

OUs 2 and 10; however, arsenic in these locations is below the MCL, and no MCL has been developed for manganese.

Note that data used for the CCRA were based on the highest concentrations detected during sampling events conducted over the last ten years. Organic COPCs in the groundwater have shown a significant decrease during that time with several plumes decreasing in size and concentrations of organic COPCs reaching non-detectable levels in some locations. Therefore, the calculated risk, if calculated today with current data, would be lower than that presented in the CCRA.

6.1.2 Future Conditions Risk Assessment (FCRA)

Future conditions groundwater risks were developed for time periods of 30, 60, and 90 years using the worst-case transport model scenario where all Huffman Dam wells and the City of Fairborn’s north well field are “turned on” and WPAFB extraction well EW-1 is “turned off” (i.e., the condition under which the greatest contaminant transport is likely to occur). In addition, COPC concentration and cumulative risk at specific locations associated with major contaminant plumes were estimated for the time period between current conditions and 30 years.

Concentrations of organic COPCs are expected to degrade significantly so that the USEPA target risk range of $1x10^{-6}$ to $1x10^{-4}$ for carcinogens and HI of 1 for noncarcinogens can be reached within 30 years (see Figure 4 for anticipated organic contamination in 30 years). In addition, the transport model indicates little or no perceivable migration of inorganic COPCs during a 90-year period. Thus the estimates of inorganic risk and hazard remain virtually unchanged over 90 years. As stated in Section 5, the projected land use for WPAFB for the reasonable future timeframe (i.e., 30 years) is as an active Air Force Base.

6.2 Ecological Risk Evaluation of Surface Water and Sediment

Ecological risks were assessed for the major surface water bodies within WPAFB. The evaluation focused on comparing detected chemical concentrations to surface water and sediment quality criteria. In addition, available ecological characterization information was used to determine whether predicted impacts were actually occurring in the environment to plant and animal species (including endangered or threatened species). Human health effects from chemicals in surface water and sediment were evaluated previously during investigations conducted for the individual OUs.

The uniformity of chemical patterns throughout the Base surface water systems and the lack of correlation of these patterns with the activities historically conducted within the OUs seems to imply sources present in the environment due to human activity, such as automobile or airplane exhaust, or pesticides used for agricultural purposes, rather than an “OU-related” source. With the exception of acetone, neither surface water nor sediment is associated with solvent contamination that exceeds water quality standards. Other constituents that were found to exceed water quality standards were a variety of inorganics, phthalates**,** polycyclic aromatic hydrocarbons (PAHs), and chlorinated pesticides. These constituents were found relatively uniformly throughout the Base and are reflective of urban environments and anthropogenic activities and not generally associated with OU-related contamination

7.0 Determination of Groundwater Remediation Goals and Removal Action Objectives

The results of the contaminant transport modeling and the risk assessments conducted on the groundwater indicate that there is actual or potential risk to nearby human populations, animals, or the food chain from hazardous substances, pollutants or contaminants. In accordance with Section 300.415(b)(2) of the NCP, these conditions warrant a groundwater removal action to mitigate these risks. An Engineering Evaluation/Cost Analysis (EE/CA) was conducted to evaluate reasonable removal action alternatives for the GWOU. Since these removal actions for the GWOU are intended to be the final actions for groundwater at WPAFB, remedial actions were formulated during the Proposed Plan to finalize the remedy for groundwater at the Base. The remedial actions will supplement the source control measures that have already occurred at the OUs and at the individual IRP sites. Remedial actions for surface water and sediment were not considered to be necessary under the NCP criteria.

Remediation goals were developed for inorganic and organic COPCs in groundwater. The first criteria for selecting areas for development of remedial alternatives was established as being those areas that exceed an MCL. These areas were then further evaluated based on risk criteria, the mobility of the contaminants present, and the existence of currently installed and operating remedial systems (leading to the exclusion of OU's 1 and 2 from consideration). Areas in which MCL exceedences occur without exceeding the risk criteria were included for long term monitoring. In addition, the areas that exceed a 10^{-4} risk level or a HI >1 were also included in the long-term monitoring network. For inorganic COPCs, the remediation goal will be the MCL or the background concentration, whichever is greater. For organic COPCs, the remediation goal will be the MCL. If the contaminant does not have an MCL, the remediation goal will be a cancer risk of $1x10^{-4}$ or a hazard quotient (HQ) of 1. In addition, if the cumulative risk posed by multiple organic COPCs exceeds a cancer risk of $1x10^{-4}$ or a HI of 1, the remediation goal will be a cumulative cancer risk of $1x10^{-4}$ or a HI of 1, whichever is less.

To achieve the remediation goals, removal action objectives (RAOs) were developed that would mitigate the risks posed to human health and the environment. The RAOs are:

- Return useable groundwater to its beneficial use within a reasonable timeframe
- Prevent off-site migration and ingestion of inorganic COPCs in groundwater that exceed the remediation goal
- Prevent off-site migration and ingestion of organic COPCs in groundwater that exceed the remediation goal
- Monitor groundwater areas that exhibit sporadic (spatial or temporal) exceedances of the remediation goal.

8.0 Description of Alternatives

An Engineering Evaluation/Cost Analysis (EE/CA) was conducted to evaluate reasonable removal action alternatives for the GWOU that would achieve the RAOs. The EE/CA addressed dissolved phase groundwater contamination within the boundaries of WPAFB and dissolved phase groundwater contamination originating at WPAFB that has migrated off-site. The EE/CA was based on the information and findings presented in the BMP-related characterization and evaluation documents and was prepared in accordance with Section 300.415(b)(4)(I) of the NCP and with USEPA guidance. Because the proposed actions are being completed as non-time critical removal actions, the EE/CA did not present a "No Action" alternative against which other alternatives can be compared. However, because this ROD presents the final remedy for WPAFB, the “No Action” alternative has been included in this document.

The EE/CA determined that two areas of the GWOU would not be restored within a reasonable time frame (i.e., longer than 30 years) without active remediation. These two areas are the TCE and PCE plume at OU5 and the vinyl chloride plume near Spill Site 11. These areas are referred to as “Further Action Area A” (FAA-A) and “Further Action Area B,” (FAA-B) respectively. The results of the transport model and FCRA indicate that TCE and PCE will persist above 1 µg/L for 60 to 90 years at OU5 without active remediation. Vinyl chloride in the plume near Spill Site 11 will persist above 1 µg/L for approximately 30 to 60 years.

For the remainder of the GWOU, the EE/CA determined that active remediation was not required to meet the goals and objectives within a reasonable timeframe. Modeling indicates that as source areas are controlled, these contaminants will attenuate and meet remediation goals. The ecological risk assessment determined that although there were wide spread detections of PAHs, chlorinated pesticides, and phthalates, and moderately elevated levels of inorganics, the constituents were reflective of an urban environment and anthropogenic activities not generally associated with contamination or activities at the operable units. Therefore, No Action is required for the remainder of the groundwater, surface water and sediment at WPAFB. Surface water will continue to be monitored in accordance with WPAFB’s current NPDES permit, which requires periodic monitoring of discharges to surface water. The groundwater in the remainder of the GWOU will be monitored under a long-term monitoring program.

Site descriptions and summaries of the alternatives evaluated for FAA-A, FAA-B and the remainder of the GWOU are provided in the following sections.

8.1 Further Action Area A

FAA-A encompasses the region from Landfill 5 (LF5) at the southwest boundary of Area C to the Huffman Dam Wellfield extending across property controlled by the Miami Conservancy District (MCD) (Figure 5). The area is approximately 4,500 feet in a northeast-southwest direction and 1,500 feet in a northwest-southeast direction covering approximately 155 acres.

Adjacent to FAA-A, west of Huffman Dam, the City of Dayton maintains two wellfields collectively referred to as the Mad River Wellfield. The first is known as Rohrer's Island Wellfield and the second is known as the Huffman Dam Wellfield. Both well fields provide drinking water to the City of Dayton.

8.1.1 General Geologic and Hydrogeologic Characteristics

FAA-A lies within a low-relief floodplain of the Mad River and is entirely within the 100-year floodplain. Portions of FAA-A west of WPAFB are within the storage basin for Huffman Dam and may be flooded seasonally. The site is underlain by alluvial and unconsolidated sedimentary deposits, which form a major regional aquifer. Alluvial deposits occur within a narrow, steep buried bedrock valley that, in general, parallels the course of the Mad River. The buried valley is carved primarily into lower permeability shale bedrock with minor limestone beds. Unconsolidated deposits within the buried valley, consisting predominately of sand and pebble gravel mixtures with local discontinuous silt and clay layers, are commonly referred to as the Buried Valley Aquifer system. The Buried Valley Aquifer within FAA-A is a designated sole source aquifer under the SDWA and the OAC. The aquifer in the area of FAA-A is a prolific source of water, yielding over 2,000 gpm to water supply wells. Groundwater generally flows toward the west-southwest across FAA-A toward the Mad River. When not disturbed by pumping, groundwater flow parallels the Mad River, and flows southwest toward the City of Dayton.

8.1.2 Contaminant Characteristics

Groundwater within FAA-A contains tetrachloroethylene (PCE), trichloroethylene (TCE) and vinyl chloride above MCLs and also contains 1,2-dichloroethylene (1,2-DCE) at elevated concentrations. These contaminants contribute to an increase in cancer risk from potential groundwater exposures of over 1×10^{-4} as described in the CCRA

Figures 6 and 7 present the horizontal extent of contamination for PCE and TCE, respectively, measured during February 1997. The extent of PCE in groundwater above the MCL (5 μg/L) extends from the vicinity of HD12 downgradient to the vicinity of MW132. The maximum concentration of PCE occurs at HD12S, at a concentration of 58 μg/L. The extent of TCE above the MCL (5 µg/L) extends from the vicinity of the CW-05 well cluster downgradient to the Mad River. The maximum concentration of TCE occurs at CW05-085, at a concentration of 170 µg/L. May 1997 monitoring data for P65 and P71 indicate TCE concentrations of approximately 2 µg/L at each well and PCE concentrations of approximately 1 µg/L in each of the wells.

FAA-A is similar in extent to the off-site portions of OU 5 as described in the OU5 Remedial Investigation (RI) Report. However, during the time period from early 1994 through early 1997, groundwater extraction systems operated at EW-1 and P65 resulting in changes in water quality in the area. The concentration of PCE in the upgradient portion of the plume has declined from approximately 70 to 140 µg/L in 1993-1994 to 58 µg/L in 1997. At MW132, PCE has declined from 12.1 µg/L in 1993 to 6.8 µg/L in 1997. TCE concentrations also declined during the 1993-1997 time period. The downgradient extent of TCE above the MCL (5 µg/L) in 1993 was to the approximate position of Huffman Dam and at a concentration of 6 µg/L in samples from well HD-9. Upgradient portions of the plume contained concentrations of approximately 370 µg/L at CW05-085. 1997 data indicate that the concentration in the upgradient portion of the plume has been reduced to approximately 170 µg/L and in the distal portions of the plume to below 1 µg/L in samples from HD9. The decrease in contaminant concentrations for TCE are depicted in Figure 8 which presents TCE concentrations in selected wells as a function of time.

Contaminant concentrations at the City of Dayton wells (P65 and P71) have also decreased. TCE in samples from P65 decreased from approximately 4 µg/L in December 1993 to approximately 2 µg/L in May 1997. PCE in samples from P65 have decreased from approximately 2.5 µg/L to approximately 1 µg/L during the same period.

Although a review of the monitoring data indicates that contaminant concentrations are decreasing, the results of the transport model and FCRA indicate that TCE and PCE will persist above 1 µg/L for 60 to 90 years at OU5 without active remediation. Therefore, the following the following five alternatives were developed for FAA-A:

- Alternative FAA-A1 – Continuation of current groundwater treatment, discharge to surface water, long-term monitoring, restrictive regulations
- Alternative FAA-A2 – Groundwater extraction via additional extraction wells, treatment of extracted groundwater by expanding the current groundwater treatment system, discharge to surface water, monitoring, restrictive regulations
- Alternative FAA-A3 – Groundwater extraction via additional extraction wells, treatment of extracted groundwater by using UV/Oxidation in place of the existing groundwater treatment system, discharge to surface water, monitoring, restrictive regulations
- Alternative FAA-A4 – In-situ treatment via chemical oxidation (Fenton's Reagent) in the vicinity of extraction well 1 (EW-1), continuation of current groundwater treatment, discharge to surface water, long-term monitoring, restrictive regulations
- Alternative FAA-A5 – No Action.

All alternatives, with the exception of the "No Action" alternative, include the common element of continuing to extract groundwater from EW-1 and subsequent treatment and discharge of groundwater. Other common elements include monitoring the groundwater and the treatment system, and the use of existing restrictive regulations to prevent contact or ingestion of contaminated groundwater until remediation goals are achieved.

Alternative A1 - Continuation of current groundwater treatment, discharge to surface water, long-term monitoring, restrictive regulations.

This alternative consists of continuing to operate the existing extraction and treatment system at the WPAFB boundary in OU5. The extraction and treatment system has been operational since December 1991 and consists of a single extraction well, EW-1. EW-1 extracts groundwater continuously at rates of up to 800 gallons per minute (gpm). Water from EW-1 is treated by air stripping in aeration tanks to remove VOCs and is then discharged to the Mad River or to West Twin Lake. This extraction and treatment system has been effective in controlling further off-site migration of groundwater contamination. This system, however, does not address that portion of the plume that has migrated off-site prior to system operation. Monitoring the groundwater and the WPAFB treatment system would be conducted periodically to assess contaminant concentrations.

Estimated Capital Cost: $0
Estimated Annual Operations and Maintenance Cost: $251,000
Estimated Present Worth (PW) Cost: $4,920,000

(PW cost is based on 30 years @ 3% discount rate)
Months to Implement: 0, currently being implemented

Alternative A2 - Groundwater extraction via additional extraction wells, treatment of extracted groundwater by expanding the current groundwater treatment system, discharge to surface water, monitoring, restrictive regulations.

This alternative would expand the current groundwater extraction and treatment system by adding two wells located in the plume and expanding the current groundwater treatment system. A total extraction rate of 2,400 gpm is expected from EW-1 and the two new wells. Monitoring the groundwater and the WPAFB treatment system would be conducted periodically to assess contaminant concentrations.

Estimated Capital Cost: $365,000
Estimated Annual Operations and Maintenance (O&M) Cost: $535,000
Estimated Present Worth Cost: $10,850,000
(PW cost is based on 30 years @ 3% discount rate)
Months to Implement: 12 months

Alternative A3 - Groundwater extraction via additional extraction wells, treatment of extracted groundwater by using UV/Oxidation in place of the existing groundwater treatment system, discharge to surface water, monitoring, restrictive regulations

This alternative would expand the current groundwater extraction system to a rate of 2,400 gpm by adding two new wells in addition to the existing extraction well (EW-1). Groundwater would be treated by ultraviolet oxidation (UV/OX) in a new treatment system that consists of one reactor capable of handling approximately 3,000 gpm. Treated water would be discharged to the Mad River or to West Twin Lake. Monitoring the groundwater and the WPAFB treatment system would be conducted periodically to assess contaminant concentrations.

Estimated Capital Cost: $1,000,000
Estimated Annual Operations and Maintenance Cost: $650,000
Estimated Present Worth Cost: $13,710,000
(PW cost is based on 30 years @ 3% discount rate)
Months to Implement: 12 months

Alternative A4 - In-situ treatment via chemical oxidation (such as Fenton's Reagent) in the vicinity of EW-1, continuation of current groundwater treatment, discharge to surface water, long-term monitoring, restrictive regulations.

The goal of this alternative is to accelerate restoration of the aquifer by treating potential source contamination in the vicinity of EW-1. A chemical oxidation process involving the injection of a strong oxidizing agent, such as Fenton's Reagent or potassium permanganate, into the aquifer would be used to destroy VOC contaminants by oxidizing the contaminants into carbon dioxide and water. This technology would not be used to remediate the portion of the plume that has migrated off-site. A pilot study is necessary for this option.

Implementation of this process would last no longer than two months and pumping from EW-1 would be temporarily suspended. At the end of the process, groundwater would be evaluated and, if contamination levels were found to be below the MCL, groundwater extraction would be suspended and long-term monitoring initiated.

Estimated Capital Cost (using Fenton's Reagent): $2,240,000
Estimated Annual Operations and Maintenance Cost: $242,000
Estimated Present Worth Cost: $6,980,000
(PW cost is based on 30 years @ 3% discount rate)
Months to Implement: 12 months

Alternative A5 - No Action

Under this alternative, the current groundwater extraction and treatment system would be shut down, no new systems would be installed or operated, and no monitoring would occur. This alternative relies solely on the City of Dayton wells to intercept and treat the contaminated groundwater; however, these wells were not intended for treatment of contaminated groundwater.

Estimated Capital Cost: $0
Estimated Annual Operations and Maintenance Cost: $0
Estimated Present Worth Cost: $0
Months to Implement: 0

8.2 Further Action Area B

FAA-B is located in Area B, near Spill Site 11 (SP11) (Figure 9) and encompasses an area of approximately 700 feet long by approximately 300 feet wide.

8.2.1 General Geologic and Hydrogeologic Characteristics

The bedrock in the vicinity of FAA-B is predominantly overlain by clay and silt rich Wisconsin Glacial till, or ground moraine, with some sand and gravel stringers. The till is a dense, heterogeneous mixture of poorly sorted, unstratified, yellowish-brown to brown silt and clay. The majority of the till in this area is thin phase, generally less than 40 feet thick. The hill area at EFD02-MW04 is comprised predominantly of silts and clays with one upper, apparently discontinuous, sand layer and one thin sand layer at an elevation of approximately 855 ft MSL. This lower sand layer continues north through the investigation area, wells SP11-MW01, SP11-MW05, and OU8-MW10D are screened in this sand. A thin, discontinuous, surficial sand layer, 2 to 3 feet thick, exists between wells SP11-MW01 and OU8-MW10D. This sand layer is above the water table. An intermediate sand and gravel layer that ranges in elevation from 877 to 864 ft MSL is common to wells SP11-MW01, SP11-MW03, and SP11-MW04. Wells SP11-MW03 and SP11-MW04 are screened in this interval which intersects the water table. Only a thin layer of fine-grained material exists above bedrock between monitoring well EFD08-MW03 and well SP11-MW06. At well EFD08-MW03 the Brassfield limestone formation which overlays the Richmond shale, is observed.

8.2.2 Contaminant Characteristics

The concentration of vinyl chloride in FAA-B is presented in Figure 9. The figure displays a continuous plume of vinyl chloride with the maximum concentration of approximately 200 μg/L in the vicinity of SP11-MW03. A singular detection of TCE at 11 μg/L is also noted at SP11-MW03. The plume is approximately 700 feet long by 300 feet wide and extends from the water table to near the bedrock surface at a depth of approximately 33 feet.

The geometry and size of the vinyl chloride groundwater concentration contours take into account several factors. First, groundwater flows toward the southwest through SP11. Second, the distribution of the vinyl chloride in the wells immediately surrounding the center of the plume (SP11-MW03, 200 μg/L) indicates the plume is not migrating to the north (SP11-MW05, ND) and only a limited amount to the east (SP11-MW04, 14 μg/L). Third, the unconsolidated material at SP11 pinches-out as the bedrock rises going towards the east from SP11. The hydraulic conductivity of the bedrock in this area is extremely low. The absence of unconsolidated material in this area impedes contaminant transport into the bedrock and from moving upgradient. Fourth, a surface water drainage channel that apparently intersects bedrock, runs along the eastern edge of SP11. This channel may also form a hydraulic boundary that would inhibit eastward contaminant migration.

The results of the transport model and FCRA indicate that vinyl chloride in the plume at FAA-B will persist above 1 µg/L for approximately 30 to 60 years without active remediation. Therefore, the following the following four alternatives were developed for FAA-B:

- Alternative FAA-B1 – Long-term monitoring
- Alternative FAA-B2 – Groundwater Collection/Cavitation – Oxidation/Surface Water Discharge/Monitoring
- Alternative FAA-B3 – In-Situ Chemical Oxidation/Monitoring
- Alternative FAA-B4 – No Action.

Alternative B1 - Long-term monitoring

Under this alternative, groundwater would be monitored to determine if contaminants were migrating and/or degrading. Because WPAFB is an operating Base with no scheduled closure, no additional institutional controls would be implemented.

Estimated Capital Cost: $0
Estimated Annual Operations and Maintenance Cost: $9,500
Estimated Present Worth Cost: $186,000
Months to Implement: 0 months

Alternative B2 - Groundwater Collection/Cavitation – Oxidation/Surface Water Discharge/Monitoring

This alternative involves the collection of groundwater via extraction wells and treatment of the groundwater via the patented cavitation/oxidation process. Extracted groundwater would be sent to an equalization tank and then into a cavitation chamber. In the cavitation chamber, the groundwater would be subjected to a dynamic pressure reduction at a constant temperature. Hydrogen peroxide is injected into the groundwater as it flows from the cavitation chamber to the UV reactor. Once in the UV reactor, the groundwater is subjected to UV radiation, which results in the destruction of VOCs. Pilot studies would be required to determine the optimal amounts of chemicals, reagents, UV energy levels, and pretreatment requirements. Treated groundwater would then be discharged to a drainage channel that runs along the eastern border of the site.

This option also includes groundwater monitoring in accordance with the WPAFB long-term monitoring plan.

Estimated Capital Cost: $403,000
Estimated Annual Operations and Maintenance Cost: $73,000
Estimated Present Worth Cost: $1,834,000
(PW cost is based on 30 years @ 3% discount rate)
Months to Implement: 12 months

Alternative B3 - In-Situ Chemical Oxidation/Monitoring

This alternative utilizes the same chemical oxidation process identified in Alternative A4, which involves the injection of a strong oxidizing agent, such as Fenton's Reagent or potassium permanganate, into the subsurface. A pilot study is necessary for this option, during which groundwater analysis would be performed and full-scale treatment implemented. At the end of full-scale treatment, groundwater would be evaluated to ensure contamination levels are below the MCL and that contaminant concentrations did not "rebound" after time. Additional monitoring after ascertaining the contaminant "rebound" had not occurred would not be necessary.

Estimated Capital Cost (using Fenton's Reagent): $341,000
Estimated Annual Operations and Maintenance Cost: $9,500
Estimated Present Worth Cost: $351,000
(PW cost is based on 30 years @ 3% discount rate)
Months to Implement: 12 months

Alternative B4 - No Action

Under this alternative, no new systems would be installed or operated, and no monitoring would occur.

Estimated Capital Cost: $0
Estimated Annual Operations and Maintenance Cost: $0
Estimated Present Worth Cost: $0
Months to Implement: 0

8.3 Remainder of GWOU

The remainder of the GWOU encompasses the entire study area, with the exception of FAA-A and FAA-B. Section 2.1.1 describes the generalized geologic and hydrogeologic characteristics of the GWOU.

Two alternatives were developed for the remainder of the GWOU:

- No Action
- Long-Term Monitoring.

Additional alternatives were not formulated for inorganic contaminants in the remainder of the GWOU since these contaminants did not generally form well-defined plumes that could be associated with OU's or other potential sources. Inorganic COPCs were detected above the remediation goal sporadically, both temporally and spatially, and sample locations which exhibited concentrations of inorganic COPCs above the remediation goal generally had other sample results where the metal is either not detected or detected at concentrations below the remediation goal. Thus, these COPCs either required no action or need to be monitored over the long-term to ascertain behavior.

Similarly, organic contaminants in the remainder of the GWOU are at concentrations that do not exceed both an MCL and the risk criteria, with the exception of OU1 and OU2. These two areas have existing remedies in place. (The risk criteria is defined as a cumulative cancer risk of $1x10^{-4}$ or a Hazard Index of 1 for organic COPCs.) Although several areas in the remainder of the GWOU exceed MCLs or exceed the risk criteria, the results of transport modeling indicate that the maximum concentration of COPCs will be less than 1 μg/L after 30 years. The cancer risk from organic COPCs will not exceed the risk criteria within 60 years, and the noncancer hazard will not exceed risk criteria within 30 years. Thus, the organic COPCs in the remainder of the GWOU either require no action or to be monitored over the long-term.

No Action

Under the No Action alternative, no systems would be installed for groundwater extraction and treatment or for in-situ treatment, and no monitoring would occur.

Estimated Capital Cost: $0
Estimated Annual Operations and Maintenance Cost: $0
Estimated Present Worth Cost: $0
Months to Implement: 0

Long-Term Monitoring

Under the long-term monitoring alternative, all areas of groundwater that exceeded the remediation goals would be monitored to ensure that the RAOs are achieved. These areas include:

- Areas that exceed MCLs for organic COPCs, but do not exceed the target risk range
- Areas that exceed a cumulative cancer risk of $1x10^{-4}$ or a HI of 1 for organic COPCs, but do not exceed MCLs
- Areas exceeding remediation goals (MCLs or background) for inorganic COPCs
- Areas with existing remedies in place (OU1 and OU2).

Estimated Capital Cost: $0
Estimated Annual Operations and Maintenance Cost: $468,000
Estimated Present Worth Cost: $9,173,000
(PW cost is based on 30 years @ 3% discount rate)
Months to Implement: 0 months

9.0 Summary of the Comparative Analysis of Alternatives

This section presents a comparative analysis of the alternatives developed for FAA-A, FAA-B, and the remainder of the GWOU. In the EE/CA, alternatives were evaluated in accordance with the USEPA guidance document *Guidance on Conducting Non-Time-Critical Removal Actions Under CERLCA* and in accordance with Section 300.415(b)(4)(I) of the NCP. These documents require that the alternatives be evaluated under only three criteria--effectiveness, implementability and cost. However, because this ROD presents the final remedy for WPAFB, the alternatives are evaluated in the Proposed Plan, and summarized in this Section in accordance with the NCP at 40 CFR 300.430(f)(1)(i). This document presents the following nine criteria for evaluating alternatives:

1) **Overall protection of human health and the environment**. Alternatives shall be assessed as to whether they can adequately protect human health and the environment from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals. This is a mandatory threshold requirement and the primary objective of the remedial program.

2) **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)**. Alternatives shall be assessed as to whether they attain ARARs of other Federal and State environmental laws or provide grounds for invoking one of the waivers included in the NCP. Compliance with ARARs is a mandatory threshold requirement.

3) **Long-term effectiveness and permanence**. Alternatives shall be assessed for the long-term effectiveness and permanence afforded, along with the degree of certainty that the alternative will prove successful. Factors that shall be considered, as appropriate, include the nature and magnitude of total residual risks, the adequacy of long-term management, reliability of the engineering and institutional controls, and the need for replacement of the remedy.

4) **Reduction of toxicity, mobility, or volume through treatment**. The degree to which alternatives employ treatment that reduces toxicity, mobility, or volume shall be assessed. Alternatives which, at a minimum, address the principal threats posed to the site and local environment through treatment shall also be identified.

5) **Short-term effectiveness**. The short-term effects of alternatives shall be assessed considering the risks that might be posed to the community, workers, and environment during implementation of an alternative and the time until protection is achieved.

6) **Implementability**. The ease or difficulty of implementing the alternatives shall be assessed by considering the degree of difficulty or uncertainty associated with construction and operation of the selected technology, the expected reliability of the technology, the ability and time required to obtain permits and approvals, availability of equipment, and available capacity of treatment, storage and disposal services.

7) **Cost**. The types of costs that shall be assessed include capital costs, O&M costs, and the net present value of capital and O&M costs. (CERCLA RI/FS guidance [EPA, 1988] requires costs to be estimated to an accuracy of plus 50 percent or minus 30 percent.)

8) **State and/or support agency acceptance**. The OEPA and the USEPA have accepted the alternative described in the proposed plan as the preferred alternative for the GWOU.

9) **Community acceptance**. The proposed plan was placed for public comment from August 1 to August 31, 1999. No comments were received on the plan indicating community acceptance of the preferred alternative for the GWOU.

The first two criteria (overall protection of human health and the environment, and compliance with ARARs) are termed threshold criteria in that each alternative must meet both criteria in order to be considered. In particular, alternatives that do not protect human health and the environment, or do not comply with ARARs (or justify a waiver), will not meet statutory requirements for the selected remedy in the ROD. The next five criteria (long-term effectiveness, reduction of toxicity, mobility and volume, short-term effectiveness, implementability, and cost) are primary balancing criteria. The final two criteria (State and/or support agency acceptance and community acceptance) were addressed after completion of the formal public hearing/comment period.

9.1 Further Action Area A

Overall protection of human health and the environment

All alternatives for FAA-A, except FAA-A5, are equally protective of public health and the environment by preventing further off-site migration of the TCE plume and eventually eliminating potential exposure to contaminated groundwater for the on-site portion of the plume. Alternatives FAA-A1, A2, A3 and A4 rely on EW-1 and any additional wells to capture and treat contaminated groundwater. The No Action alternative (A5) relies solely on the City of Dayton wells to intercept and treat the contaminated groundwater; however, these wells were not intended for treatment of contaminated groundwater.

Restrictive regulations are currently in place (Ohio Administrative Code [OAC] 3745-9 and 3701-28) that prevent exposure to contaminated groundwater under all alternatives by prohibiting the installation of private wells within the contaminated zone and ensuring that adequate treatment will be implemented for public water supplies.

Compliance with ARARs

Alternatives FAA-A1 through A4 will eventually comply with ARARs. Under Alternative FAA-A1, the results of the contaminant transport model indicate that MCLs will be achieved within 60 to 90 years and the USEPA accepted risk range will be achieved within 30 years. Alternatives A2 and A3 would comply with ARARs within a shorter timeframe than that projected for Alternative A1. For Alternative A4, ARARs will be achieved in the on-site portion of the contaminant plume soon (within 6 months) after implementation. It is also likely that ARARs will be achieved in the downgradient portion of the plume in a lesser period of time under Alternative A4 than Alternatives A1 through A3 because the upgradient contaminant mass will have been destroyed. Injection of oxidizers and other chemicals into the subsurface under Alternative A4 must comply with OAC 3745-34-13 and will require coordination with the OEPA Underground Injection Control group. The No Action alternative will not meet ARARs because it permits contamination to migrate unchecked across Base boundaries.

Long-term effectiveness and permanence

Alternative A1 will provide long-term effectiveness and permanence. Monitoring data from the current groundwater extraction and treatment system indicates that extraction of groundwater at EW-1 has been effective in controlling further off-site migration and that the treatment system is capable of treating the groundwater successfully. Alternative A1 will require long-term operation, maintenance, and monitoring, as the timeframe for achieving remedial objectives is approximately 60 to 90 years. The reliability of the current system is high, although required maintenance must be conducted to ensure this reliability. In addition, improvements to the current treatment system have been proposed which would make it more cost efficient.

Alternative A2 also provides long-term effectiveness and performance. Alternative A2 relies upon additional extraction wells installed and maintained by WPAFB to capture contaminated groundwater not within the capture radius of EW-1. The same treatment system proposed for Alternative A1 would be used for Alternative A2, therefore, the long-term effectiveness and permanence of Alternative A2 is similar to that of A1.

The long-term effectiveness and performance of Alternative A3 is questionable. Although this alternative relies upon the same systems for extraction of groundwater as Alternative A2, the long-term reliability of the UV/Oxidation treatment system is questionable, which could lead to the need to replace the treatment portion of the remedy.

The long-term effectiveness and performance of Alternative A4 is also questionable. Although in-situ oxidation has been demonstrated to be effective for the contaminants of interest, high groundwater velocities may reduce the effectiveness of this technology. However, the effectiveness of this technology could be demonstrated in a pilot test prior to full-scale implementation.

The No Action alternative would likely not provide long-term effectiveness since The City of Dayton wells at Huffman Dam were not intended for treatment of contaminated groundwater. Furthermore, the time to achieve ARARs by this alternative would be excessive.

Reduction of toxicity, mobility, or volume through treatment

Alternatives A1 through A4 satisfy the statutory requirement for reducing contaminant toxicity, mobility or volume through treatment. Alternatives A1 and A2 rely upon the current groundwater treatment system to reduce the toxicity of contaminants by removing them from the groundwater via a stripping process and capturing them using activated carbon. Contaminants are eventually destroyed or recycled during regeneration of the carbon. Alternatives A3 and A4 reduce contaminant toxicity by directly oxidizing the contaminants, resulting in the formation of carbon dioxide, water, and salts. The No Action alternative does not directly reduce the toxicity, mobility or volume of the contaminants, although the toxicity may be reduced through attenuation of the contaminants.

Short-term effectiveness

Alternatives A1 through A4 will prevent off-site migration and ingestion of COPCs that exceed the remediation goal. Alternative A4 has the potential for returning the aquifer to its beneficial use within the shortest timeframe. Alternatives A1 through A3 will return the aquifer to its beneficial use in less than 60 to 90 years. The No Action alternative will take the longest period of time to return the aquifer to its beneficial use.

All alternatives would be protective of workers during implementation.

Implementability

Alternative A1 presents the least technical difficulties for implementation. This alternative is currently being implemented and has demonstrated effectiveness in preventing off-site migration and in treating extracted groundwater. Alternatives A2, A3, A4, and the No Action alternative become increasingly more difficult to implement, with A4 being technically the most difficult. Established agreements prevent discontinuing operation of the current groundwater extraction and treatment system, as would occur under the No Action alternative.

Services and materials required to implement Alternatives A1, A2, A3 and the No Action alternative are readily available. Alternative A4 is somewhat more difficult to implement.

Alternative A1 is the least administratively difficult alternative to implement. Access permits would be required for implementation of Alternatives A2 and A3, and implementation of A4 will require coordination with the OEPA Underground Injection Control group and compliance with OAC 3745-34-13. The No Action alternative would require all parties associated with current agreements to consent to discontinue groundwater treatment operations.

Cost

The No Action alternative is the least costly alternative, with Alternatives A1, A4, A2, and A3 becoming increasingly more costly.

State acceptance

The State is in acceptance of the alternatives presented in the Proposed Plan.

Community acceptance

The Community is in acceptance of the alternatives presented in the Proposed Plan.

9.2 Further Action Area B

Overall protection of human health and the environment

Alternative B3 will be protective of human health and the environment, as in-situ oxidation will immediately reduce contaminant levels in the saturated zone. Alternative B2 may not be protective of the environment because the groundwater extraction system may not effectively remove contaminants from the subsurface. Alternative B1 is not protective in the short-term because contaminant levels will not be reduced and no provisions are made to prohibit migration. Alternative B1 is protective in the long-term because contaminant levels may naturally attenuate, and monitoring would be conducted to ensure that exposure to contaminants did not occur. The No Action alternative is not protective of human health and the environment because no provision is made to reduce contaminant levels or prohibit migration.

Compliance with ARARs

All alternatives, except the No Action alternative, are expected to comply with ARARs. Alternatives B1 and B2 will eventually comply with ARARs, but not within the immediate timeframe. Injection of oxidizers and other chemicals into the subsurface under Alternative B3 must comply with OAC 3745-34-13 and will require coordination with the OEPA Underground Injection Control group. Within a year after implementing Alternative B3, contaminant concentrations within the treatment zone will likely meet MCLs. Results of the Contaminant Transport Model indicate that, for Alternatives B1, B2, and the No Action alternative, contaminant levels in this area will meet MCLs within 25 to 30 years.

Long-term effectiveness and permanence

Alternative B3 would likely provide long-term effectiveness and permanence, although a pilot test would be required to confirm the effectiveness of the in-situ oxidation process and monitoring would be required to assess the permanence of the remedy. The long-term effectiveness and permanence of Alternatives B1 and B2 is unknown. Because Alternative B1 does not rely upon a treatment system, there are no concerns associated with the performance or replacement of the remedy. It is likely that contaminants will naturally attenuate and levels will be reduced to MCLs within 25 to 30 years. The performance of the Alternative B2 extraction system to effectively remove contaminants is questionable in this area. In addition, the proposed treatment system may require a high level of operation and maintenance for continued effectiveness.

Reduction of toxicity, mobility, or volume through treatment

Alternatives B2 and B3 satisfy the statutory requirement for reducing toxicity, mobility or volume through treatment; Alternatives B1 and the No Action alternative do not. Alternative B2 reduces the toxicity of the contaminants by oxidizing them to carbon dioxide, water, and salts. However, this reduction in toxicity only applies to the extracted groundwater that is treated. Alternative B3 also reduces the toxicity of the contaminants by oxidation; however, it is likely that more of the contaminants will be destroyed than under Alternative B2 because Alternative B3 does not rely upon an inefficient extraction process.

Short-term effectiveness

Alternative B3 will reduce potential risk and achieve MCLs in the shortest timeframe (within 1 year); Alternatives B1, B2, and the No Action alternative will reduce potential risk within 30 years or less.

The No Action alternative and Alternative B1 are the most protective of workers, as few construction activities would be conducted that would potentially expose workers to contaminants. Alternatives B2 and B3 pose a greater risk than Alternative B1 to workers; however, these risks are expected to be minimal and exposure would be monitored under a Health and Safety Plan.

Implementability

Alternative B3 may present some technical difficulties during implementation due to the difficulty in controlling injection into the heterogeneous aquifer matrix. Alternative B2 is the most difficult to implement technically because of the large number of wells required in a small area and the suspected inability of the extraction system to remove contaminants from the subsurface. Alternative B1 is the most easily implemented alternative, as there are no construction activities associated with this alternative. Services and materials required to implement Alternatives B1 and B2 are readily available.

Alternatives B1 and B2 are easily implemented, administratively. Alternative B3 is somewhat more difficult to implement because injection of oxidizers and other chemicals into the subsurface must comply with OAC 3745-34-13, and will require coordination with the OEPA Underground Injection Control group.

Cost

The No Action alternative is the least costly alternative. Alternative B2 is the most costly, followed by B3 and B1. The present worth cost for Alternative B3 is approximately twice the present worth cost of Alternative B1. Alternative B2 is approximately five times greater than the present worth cost of Alternative B3.

State acceptance

The State is in acceptance of the alternatives presented in the Proposed Plan.

Community acceptance

The Community is in acceptance of the alternatives presented in the Proposed Plan.

9.3 Remainder of GWOU

Overall protection of human health and the environment

The long-term monitoring alternative is protective of human health and the environment. Inorganic COPCs were detected infrequently and are likely to be naturally occurring. The results of the transport model indicate that inorganic COPCs do not migrate and, thus, potential exposures to contaminated groundwater are controlled. Areas of groundwater where organic COPCs exceed remediation goals are either upgradient of a groundwater extraction system or there are no receptors for exposures to occur. For all areas of concern, a variety of institutional controls and lack of receptors prevent contact with groundwater.

The No Action alternative is not protective of human health and the environment because no monitoring would occur to ensure that contaminant migration was not occurring or that exposure to groundwater was controlled.

Compliance with ARARs

The long-term monitoring alternative is expected to comply with ARARs for organic COPCs. Modeling indicates that as source areas are controlled, the organic COPCs will attenuate and will meet MCLs within a period of 30 years, with the exception of vinyl chloride at OU1 and the area near Spill Site 11, and benzene at UST71A (OU8) and OU2. The area near Spill Site 11 is expected to meet MCLs within 65 years. OU1 and OU2 have existing remedies in place, and recent remedial efforts have reduced the concentration of benzene at UST71A to nondetectable levels.

Although several areas exceeded MCLs for inorganic COPCs (and, therefore, chemical-specific ARARs), the frequency of detection of inorganic COPCs above MCLs is very low. Additionally, sample locations that exhibited inorganic compound concentrations exceeding MCLs typically had other sample results where the metal was either not detected, or detected at concentrations below the MCL. In addition, there is no evidence that inorganic wastes disposed at WPAFB are the source of metals contamination in groundwater. The inorganic COPCs may be naturally occurring.

Although the No Action alternative may also comply with ARARs, no monitoring would be conducted to confirm contaminant concentrations.

Long-term effectiveness and permanence

The long-term effectiveness and permanence of long-term monitoring will be evaluated during periodic monitoring events and the on-going evaluation of monitoring data. Modeling indicates that MCLs and risk criteria will be achieved in all areas for organic COPCs. Ongoing monitoring will confirm that inorganic COPCs are not migrating and will evaluate whether these compounds are naturally occurring.

The No Action alternative would not provide long-term effectiveness nor permanence, as there would be no data to assess whether organic contaminant concentrations were decreasing and whether inorganics were migrating.

Reduction of toxicity, mobility, or volume through treatment

The toxicity, mobility or volume will not be affected by the long-term monitoring alternative, nor by the No Action alternative. However, organic COPCs will naturally attenuate with time, eventually reducing their toxicity.

Short-term effectiveness

The long-term monitoring alternative is expected to confirm RAOs are being met. Modeling indicates that as source areas are controlled, organic COPCs will attenuate and contaminant concentrations will meet remediation goals. Results of the transport model indicate that inorganic COPCs do not migrate over a 90- year modeling period. The No Action alternative will not confirm that plume migration and contaminant attenuation are occurring as predicted in the Contaminant Transport Model.

Workers may be exposed to contaminants during the periodic sampling events; however, contaminant exposure would be minimized and monitored through the implementation of proper health and safety precautions. No worker exposure will occur under the No Action alternative.

Implementability

The long-term monitoring alternative is technically feasible and is currently being implemented under the interim monitoring plan presented in the EE/CA. No permits are required, nor are easements or right-of-ways required.

The long-term monitoring alternative is easily and immediately implemented. Outside contractor and laboratory services are readily available in the local area. The No Action alternative is also technically feasible and easily implemented.

Cost

There is no capital cost associated with long-term monitoring. The estimated annual cost for long-term monitoring for areas other than FAA-A and FAA-B is approximately $468,000. The present worth cost for 30 years of long-term monitoring is approximately $9,173,000. There is no cost associated with the No Action alternative.

State acceptance

The State is in acceptance of the alternatives presented in the Proposed Plan.

Community acceptance

The Community is in acceptance of the alternatives presented in the Proposed Plan.

10.0 The Selected Remedy

The Air Force, Ohio EPA and USEPA have selected alternatives A1 (FAA-A), B3 (FAA-B), Long-term Monitoring (remainder of GWOU) and No Action (surface water and sediment) as the remedy for the GWOU. The primary aspects of these alternatives are:

- Alternative FAA-A1 - Continue current groundwater extraction, treatment and discharge at the WPAFB property boundary in OU5 and continue long-term monitoring in this area.
- Alternative FAA-B3 - In-situ chemical oxidation in the area near Spill Site 11 and monitoring.
- Long-term monitoring. Those areas to be monitored are:
  - Areas that exceed Maximum Contaminant Levels (MCLs) for organic contaminants of potential concern (COPCs), but do not exceed the target risk range of $1x10^{-4}$ to $1x10^{-6}$.
  - Areas that exceed a cumulative cancer risk of $1x10^{-4}$ or a Hazard Index of 1 for organic COPCs, but do not exceed MCLs.
  - Areas exceeding remediation goals (MCLs or background) for inorganic COPCs.
  - Areas with existing remedies in place (OU1 and OU2).

– No action for surface water and sediment. Surface water will continue to be monitored in accordance with WPAFB's National Pollutant Discharge Elimination System (NPDES) permit.

Remediation goals were developed for inorganic and organic COPCs in groundwater. For inorganic COPCs, the remediation goal will be the MCL or the background concentration, whichever is greater. For organic COPCs, the remediation goal will be the MCL. If the contaminant does not have an MCL, the remediation goal will be a cancer risk of $1x10^{-4}$ or a hazard quotient (HQ) of 1. In addition, if the cumulative risk posed by multiple organic COPCs exceeds a cancer risk of $1x10^{-4}$ or a HI of 1, the remediation goal will be a cumulative cancer risk of $1x10^{-4}$ or a HI of 1, whichever is less. Remediation goals for inorganic and organic COPCs are provided in Table 1.

To achieve the remediation goals, removal action objectives (RAOs) were developed that would mitigate the risks posed to human health and the environment. The RAOs are:

- Return useable groundwater to its beneficial use within a reasonable timeframe
- Prevent off-site migration and ingestion of inorganic COPCs in groundwater that exceed the remediation goal
- Prevent off-site migration and ingestion of organic COPCs in groundwater that exceed the remediation goal
- Monitor groundwater areas that exhibit sporadic (spatial or temporal) exceedances of the remediation goal.

The selected remedy will consist of the components outlined in the following subsections.

10.1 Remedy Description for FAA-A

The remedy for FAA-A will consist of continuing to extract and treat groundwater using the current extraction well (EW-1) and groundwater treatment system (GWTS) until remediation goals are achieved. The purpose of groundwater extraction at EW-1 is to prevent off-site migration of contaminated groundwater at the WPAFB property boundary. With the approval of OEPA and USEPA, extraction of groundwater at EW-1 may be pulsed to achieve higher mass removal rates.

The GWTS has been operational since December of 1991 and consists of a single extraction well (EW-1) operating continuously at extraction rates of up to 800 gpm. Water discharged from EW-1 is treated in the GWTS. Figure 10 shows the process flow diagram for the GWTS. The system design includes:

- Two, three-chamber 20,000-gallon rectangular aeration tanks
- One 4,000-gallon degas/discharge tank
- Six 500-cfm aeration blowers (one for each chamber)
- Air diffusion network (66 dome diffusers per chamber)
- Two variable-speed exhaust blowers (one on-line/one standby)
- Two 1,000-cfm vapor-phase carbon adsorbers
- Distributed control system for system operation and monitoring.

Groundwater is pumped from the vertical extraction well through the two aeration tanks in series where it is sparged with air to strip the volatile organic compounds (VOCs). Each aeration tank is subdivided by baffles (with bottom flow cutouts) into three equal-volume chambers (or stages), with fine bubble diffusers arranged across the entire bottom surface of each chamber. Air is delivered to the diffusers by positive displacement (rotary) aeration blowers.

Air from the first two chambers in each tank exhausts through demisters to remove entrained water vapor droplets. Water collected in the demisters drains back into the respective chambers. The combined airflow from the first two chambers is drawn through an exhaust blower and passes through two vapor-phase carbon adsorbers in series to remove volatilized VOCs prior to being vented to the atmosphere. Air exhausted from the last four chambers is vented to the atmosphere and monitored.

The treated water flows by gravity from the second aeration tank into the degas tank. In the degas tank, the air bubbles disengage from the water. The water is then removed by variable frequency drive discharge pumps. During normal operation, one discharge pump operates up to the maximum design flow. The second pump serves as a spare which will turn on automatically in the event of an abnormally high water level in the degas tank (this could occur from failure of the primary pump or if the influent flow to the GWTS exceeds the capacity of the primary pump). The treated water is discharged to Twin Lakes or the Mad River. This discharge is governed by a NPDES permit.

The water level in the entire system is controlled by a level control system in the degas tank. Because flow between tanks is essentially unrestricted, the water level in all of the tanks is approximately equal. The control system adjusts the pump speed to control tank levels.

In addition to the remedy described above for FAA-A, an evaluation of the performance of a chemical oxidation pilot test in the EW-1 vicinity, as described in Alternative FAA-A4, is also recommended. The use of chemical oxidation in the high concentration areas of FAA-A has the potential to significantly reduce the time necessary to achieve the RAOs. However, the effectiveness and implementability of in-situ oxidation in the hydrogeological setting at FAA-A requires further evaluation. Therefore, a pilot test is recommended while continuing to implement the primary remedy. During implementation of the pilot test, extraction at EW-1 may be temporarily discontinued.

10.2 Remedy Description for FAA-B

The remedy for FAA-B will consist of in-situ oxidation. A strong oxidizer will be injected into the subsurface to oxidize organic contaminants. Various chemical oxidants as well as various processes for injection are available. Therefore, the oxidant and process to be used will be determined during the design phase. An initial treatment phase will be conducted during which time the rate of injection of the reagents (oxidant) will be determined and site data will be collected to determine the radius of influence of the injection points and reagent dose. If remediation goals are not achieved during the Initial Treatment Phase, in-situ oxidation will be implemented at full-scale.

Following the treatment phases, post-treatment sampling will be conducted to ensure that remediation goals have been achieved.

10.3 Remedy Description for the Remainder of the GWOU

The remedy for the remainder of the GWOU will be long-term monitoring. Those areas to be monitored are:

- Areas that exceed Maximum Contaminant Levels (MCLs) for organic contaminants of potential concern (COPCs), but do not exceed the target risk range of $1x10^{-4}$ to $1x10^{-6}$.
- Areas that exceed a cumulative cancer risk of $1x10^{-4}$ or a Hazard Index of 1 for organic COPCs, but do not exceed MCLs.
- Areas exceeding remediation goals (MCLs or background) for inorganic COPCs.
- Areas with existing remedies in place (OU1 and OU2).

The monitoring plan has been provided as Attachment 1 to this ROD.

11.0 Statutory Determination

Based on consideration of the requirements of CERCLA, the comparative analysis, and public comments, WPAFB, USEPA, and OEPA believe the selected remedy for the GWOU provides the best balance of trade-offs among the alternatives with respect to the criteria used to evaluate the remedies. The selected remedy is consistent with CERCLA and, to the extent practicable, complies with the NCP. The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedy, is cost-effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable. The selected remedy satisfies the statutory preference for treatment as a principal element.

11.1 Protection of Human Health and the Environment

The selected remedy is protective of human health, the community and the environment. Monitoring data from the current GWTS at FAA-A indicates that extraction of groundwater at EW-1 has been effective in controlling further off-site migration of groundwater contamination. In addition, restrictive regulations currently in place (Ohio Administrative Code 3745-9 and 3701-28) would be effective in preventing exposure to contaminated groundwater. At FAA-B, in-situ oxidation will likely result in an immediate reduction of contaminant concentrations at or below the remediation goal. The long-term monitoring alternative for the remainder of the GWOU is also protective of human health and the environment. Long-term monitoring will determine if the conclusions of the contaminant transport model are valid, and will ensure that appropriate actions can be implemented if monitoring indicates that COPCs are migrating. Inorganic COPCs were detected infrequently and are likely to be naturally occurring. The results of the transport model indicated that inorganic COPCs do not migrate and thus, potential exposures to contaminated groundwater are controlled. Areas of groundwater where organic COPCs exceed remediation goals are either upgradient of a groundwater extraction system or there are no receptors for exposures to occur. For all areas of concern the institutional restrictions inherent to a military installation and restrictive regulations (OAC 3745-9 and 3701-28) prevent exposure to contaminated groundwater. This access restriction is applicable to the installation of private wells and new public water supply well fields. Public water supply wells will require approval from the State of Ohio prior to installation. WPAFB, as an active military installation, will control the installation of private wells.

11.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy complies with ARARs. A list of ARARs for the remedy is provided in Table 2. The results of the contaminant transport model indicates that MCLs will be achieved at FAA-A within 60 to 90 years, and the USEPA accepted risk range will be achieved with 30 years. At FAA-B, contaminant concentrations within the treatment zone will likely meet MCLs within weeks or months after oxidizer injection. For the remainder of the GWOU, modeling indicates that as source areas are controlled, organic COPCs will attenuate and will meet MCLs within a period of 30 years, with the exception of vinyl chloride at OU1, which is expected to meet MCLs within 65 years. The frequency of detection of inorganic COPCs above the MCL in the remainder of the GWOU is very low, and inorganic COPCs may be naturally occurring.

11.3 Cost-Effectiveness

The remedy is cost effective. The anticipated cost for the remedy is provided in Table 3. The remedy for FAA-A is the least costly alternative (other than No Action) of all alternatives evaluated. Although Alternative B3 is approximately twice as costly as the lowest cost alternative (other than no action), the effectiveness of the other alternatives are questionable. Long-term monitoring is also a cost-effective alternative for the remainder of the GWOU, as monitoring will likely provide data to indicate that inorganic COPCs are not a threat to human health and the environment, and that organic COPCs will attenuate or be captured in a downgradient extraction system prior to migrating off-site.

11.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy utilizes permanent solutions and alternative treatment technologies and provides the best balance of tradeoffs with respect to the five balancing criteria. Extraction and treatment of groundwater using the existing system at FAA-A permanently removes contaminants from groundwater and will achieve the remedial goals within a reasonable timeframe and cost. The current groundwater extraction and treatment system has demonstrated effectiveness in controlling off-site migration of contaminated groundwater and monitoring data has shown steady decreases in groundwater contaminant concentrations.

In-situ oxidation at FAA-B also provides the best balance of tradeoffs with respect to the five balancing evaluation criteria. In-situ oxidation will result in an almost immediate reduction of contaminant concentrations and is not unreasonably costly. Although in-situ oxidation may be more difficult to implement than other alternatives, the short-term and long-term effectiveness of the alternative is greater than other alternatives. Alternative B3 utilizes permanent solutions and an innovative treatment technology.

Long-term monitoring for the remainder of the GWOU also provides the best balance of tradeoffs with respect to the five balancing criteria. Source areas have been controlled, (in previous RODs for WPAFB) and, where needed, groundwater removal actions have occurred or are currently being proposed. These groundwater removal actions and the source control actions will remove the principal threats to groundwater and will continue as necessary until remedial goals are met. Monitoring of the remainder of the GWOU will confirm that inorganic COPCs are not migrating and that they may be naturally occurring. Monitoring will also confirm that organic COPCs are attenuating. The areas to be monitored are directly upgradient of an existing extraction system or there are no receptors, thus exposure to contaminated groundwater is controlled. All areas of groundwater that exceeded the remediation goals for inorganic and organic COPCs will be monitored to ensure that the RAOs are achieved.

12.0 Documentation of No Significant Change

The Proposed Plan for the GWOU was released for public comment on August 2, 1999 and a public meeting was held on August 9, 1999. The Proposed Plan identified Alternative FAA-A1, Alternative FAA-B3, Long-term monitoring, and No Action for Surface Water and Sediment as the most appropriate remedy. No comments, verbal or written, were received either at the public meeting or during the comment period. As a result, no significant changes are necessary to the proposed remedies as identified in the Proposed Plan.

III RESPONSIVENESS SUMMARY

Pursuant to CERCLA Section 117, the Proposed Plan was issued for the GWOU for public comment on August 1, 1999. A public meeting was held on August 9, 1999. The public comment period expired on August 31, 1999. No comments, verbal or written, were received either at the public meeting or during the comment period.

Index of Documents in the Administrative Record Pertinent to the Groundwater Operable Unit

Final Site Specific Work Plan for Remedial Design Tasks, Basewide Monitoring Program (with addendum), IT Corporation, August 1995

Results of Soil and Groundwater Sampling (Validated), IT Corporation, January 1996

Results of Groundwater, Surface Water and Sediment Sampling (Validated), IT Corporation, February 1996

Background Technical Memorandum, IT Corporation, September 1996

Field Activities Technical Memorandum, IT Corporation, September 1996

Groundwater Flow Modeling Technical Memorandum, IT Corporation, January 1997

Groundwater Transport Modeling Technical Memorandum, IT Corporation, June 1998

Current Conditions Human Health Risk Assessment, IT Corporation, May 1997

Future Conditions Human Health Risk Assessment, IT Corporation, February 1998

Ecological Risk Assessment, IT Corporation, April 1999

Engineering Evaluation/Cost Analysis, Groundwater Basewide Monitoring Program, IT Corporation, March 1999

Proposed Plan for the Groundwater Operable Unit, IT Corporation, July 1999

Table 1

COPC Remediation Goals
Wright-Patterson AFB, Ohio

Inorganic COPCs	MCL (µg/l)	Remediation Goal Layer 1 Hill (µg/l)	Remediation Goal Source	Remediation Goal Layer 1 Valley (µg/l)	Remediation Goal Source	Remediation Goal Layer 2 Valley (µg/l)	Remediation Goal Source	Remediation Goal Layer 3 Valley (µg/l)	Remediation Goal Source
Aluminum	-	12000	Background	19900	Background	960	Background	1290	Background
Antimony	6	40	Background	32.2	Background	36.9	Background	6	MCL
Arsenic	50	50	MCL	50	MCL	50	MCL	50	MCL
Barium	2000	2000	MCL	2000	MCL	2000	MCL	2000	MCL
Chromium	100	309	Background	100	MCL	100	MCL	100	MCL
Cobalt	-	13	Background	24.8	Background	50	MDL[1]	8	Background
Copper	1300	1300	MCL	1300	MCL	1300	MCL	1300	MCL
Lead	15	20	Background	55.5	Background	15	MCL	15	MCL
Manganese	-	707	Background	1640	Background	134	Background	184	Background
Nickel	100	119	Background	137	Background	100	MCL	100	MCL
Selenium	50	50	MCL	50	MCL	50	MCL	50	MCL
Thallium	2	2	MCL	3.1	Background	2.6	Background	2	MCL
Vanadium	-	30	Background	56	Background	4.2	Background	50	MDL[1]
Zinc	-	115	Background	271	Background	10.7	Background	12.6	Background

µg/l = micrograms per liter
MDL = Method Detection Limit
- = MCL not available
[1] MCL not available and compound was not detected in background data set

Table 1

COPC Remediation Goals
Wright-Patterson AFB, Ohio

Organic COPCs	Remediation Goal All Layers (μg/l)	Remediation Goal Source
Benzene	5	MCL
1,2-DCA	5	MCL
1,2-DCE	70	MCL
Ethylbenzene	700	MCL
PCE	5	MCL
Toluene	1000	MCL
TCE	5	MCL
Vinyl Chloride	2	MCL
Xylenes	10000	MCL
Bis(2-ethylhexyl)phthalate	6	MCL
4,4-DDT	20	risk-based[2]
OCDD	0.045	risk-based[2]

μg/l = micrograms per liter
MDL = Method Detection Limit
- = MCL not available
[1] MCL not available and compound was not detected in background data set
[2] MCL not available, remediation goal based on $1x10^{-4}$ cancer risk

Table 2

Summary of ARARs for WPAFB BMP GWOU
Wright-Patterson AFB, Ohio

Chemical-Specific ARARs

Air

- *40 CFR 50, National Ambient Air Quality Standards (NAAQS)* are established under the Clean Air Act for conventional air pollutants, such as carbon monoxide, nitrogen dioxide, particulate matter equal to or less than 2.5 microns particle size, ozone, and sulfur dioxide.

- *40 CFR 53, Ambient Air Monitoring Reference and Equivalent Methods* provides methods for monitoring conventional air pollutants in ambient air.

- *40 CFR 61 and 63, National Emission Standards for Hazardous Air Pollutants (NESHAPS)* are established under the Clean Air Act for seven hazardous air pollutants, including benzene and vinyl chloride.

- *OAC 3745-17-02 (A-C); -03 and –05, Emissions of Particulate Matter* establishes standards and methods of measurement for total suspended particulates and prohibits degradation of air quality.

These standards are applicable because air stripping is part of selected remedy FAA-A1. In addition, benzene and vinyl chloride have been selected as chemicals of concern (COCs) for the GWOU. Emissions from these sources will be controlled and are not expected to be significant. However, WPAFB is, in its entirety, considered a "major source".

Drinking Water

- *40 CFR 141, Federal Drinking Water Standards* are established under the Safe Drinking Water Act and provide Maximum Contaminant Levels (MCLs) and /or Maximum Contaminant Level Goals (MCLGs) for water delivered to a free flowing outlet of the ultimate user of a public water system. These values are relevant and appropriate for selected remedies FAA-A1 and FAA-B3 and for the remainder of the GWOU to protect potential drinking water sources. Chemical-specific values for COCs associated with this groundwater operable unit are provided in Table 1 of this ROD.

- *OAC 3745-81, Ohio Drinking Water Standards* establish Maximum Contaminant Levels (MCLs) and /or Maximum Contaminant Level Goals (MCLGs) for water delivered to a free flowing outlet of the ultimate user of a public water system. These values are relevant and appropriate to selected remedies FAA-A1, FAA-B3 and the remainder of the GWOU for protection of potential drinking water sources.

- Toxicity values from the "Integrated Risk Information System" (IRIS) and the "Health Effects Assessment Summary Tables" are to be considered for the purpose of determining a protective level in the absence of a chemical-specific ARAR.

Surface Water

- *40 CFR 130 and 131, Ambient Water Quality Criteria and Water Quality Criteria* are established under the Clean Water Act (Section 303 and 304). These sections define criteria for protection of human health and aquatic organisms, which must be met or exceeded by the states in establishing water quality standards for surface water.

- *OAC 3745-1-04 (A – E); -05 (A,B,C); -06 (A,B); and –07 (C), Water Quality Standards* specify criteria applicable to all waters, antidegradation, mixing zones, and water use designations, and criteria.

These criteria are relevant and appropriate to Alternative FAA-A1 because this selected remedy includes discharge of treated water to surface water. Furthermore, they are relevant and appropriate to FAA-A1, FAA-B3, and the remainder of the GWOU because of the potential for discharge of contaminated groundwater to surface water via hydraulic connections.

Hazardous Waste Management

- *40 CFR 264, Subpart F, Releases from Solid Waste Management Units*, under the Resource Conservation and Recovery Act (RCRA), specifies facility permit concentration limits in the groundwater for hazardous constituents. These limits are relevant and appropriate to groundwater treatment under Alternatives FAA-A1 and FAA-B3.

- *OAC 3745-51-24 and 33; OAC 3745-54-13, General Waste Analysis* describes criteria for determining whether a waste is a hazardous waste and is relevant and appropriate for Alternative FAA-A1. Spent carbon from the carbon adsorption process may require disposal as a hazardous material.

Location-Specific ARARs

Cultural Resources

- *16 USC 470, National Historic Preservation Act and 36 CFR 800, Protection of Historic and Cultural Properties*, requires action to take into account effects on properties included in and/or eligible for the National Register of Historic Places and to minimize harm to National Historic Landmarks. Due to the nature and location of the FAAs as well as the selected remedies, it is unlikely that cultural resources will be encountered. These ARARs have been included as relevant and appropriate regulations because cultural resources have been identified at other locations on WPAFB.

Natural Resources

- *16 USC 661, Fish and Wildlife Coordination Act*
- *33 CFR 320, Navigation and Navigable Waters, General Regulatory Policies*
- *40 CFR 6, Procedures for Implementing the Requirements of the Council on Environmental Quality*
- *16 USC 1531, Endangered Species Act of 1973 and Regulations*
- *50 CFR 200 and 402, Wildlife and Fisheries, Interagency Cooperation*
- *Executive Order 11990, Protection of Wetlands*
- *Executive Order 11988, Floodplain Management*

These federal regulations are applicable to Alternatives FAA-A1 and FAA-B3 due to the need to protect wetlands, floodplains, and endangered species. These ARARs provide for consultation with U.S. FWS regarding proposed actions for the site where appropriate. In particular, FAA-A1 will be carried out in proximity to wetlands, within a floodplain, and within the range where listed species have been observed in the past.

- *ORC 1518.02, Endangered Plant Species*
- *OAC 1501-18-1, List of Endangered Plant Species*
- *OAC 1501: 31-23-01 (A and B), List of Endangered Animal Species*

These state ARARs prohibit removal or destruction of endangered plant or animal species considered endangered in Ohio. These regulations are relevant and appropriate for activities that might disrupt habitats.

Action-Specific ARARs

Discharge to Surface Water

- *40 CFR 122.41 and 122.44, EPA Administered Permit Programs*
- *40 CFR 125 (Subpart K), Criteria and Standards for National Pollutant Discharge Elimination System (NPDES)*

Regulations under NPDES provide requirements for: 1) monitoring treatment system effluent; 2) compliance with additional substantive conditions; 3) compliance with Federally-approved State water quality standards; and 4) use of Best Available Technology (BAT). These ARARs are applicable to FAA-A1 because this alternative involves the discharge of treated water to surface water. The groundwater treatment facility associated with FAA-A1 operates under an individual NPDES permit. In addition, WPAFB applied for an individual NPDES permit renewal for base-wide stormwater discharges in September 1998. Response to this application is pending. Further requirements are outlined in the following ARARs:

- *40 CFR 136, Test Procedures for the Analysis of Pollutants* provides detailed requirements for analytical procedures an quality controls, which are relevant and appropriate to FAA-A1 due to surface water discharge.

- *33 CFR 330, Nationwide Permit Program Regulations* describes the policy and procedures used to issue, modify, suspend, or revoke a nationwide permit designed to regulate activities which may impact navigable waters of the U.S. These regulations are relevant and appropriate to Alternative FAA-A1, which involve discharge to surface water.

- *ORC 6111.04.2, Rules Requiring Compliance with National Effluent Standards* requires compliance with national effluent limitations, national standards of performance for new sources, and national toxic and pretreatment effluent standards unless a permit has been issued under Section 6111.03.

- *ORC 3767.13 and .14, Prohibition of Nuisances* defines nuisances that are prohibited in the waterways and are relevant and appropriate to discharges to surface waters associated with FAA-A1.

- *ORC 6111.04 and .07 (A,C), Pollution Prohibitions* prohibits pollution of waters of the state and describes the duty to comply with water pollution control requirements. These ARARs are relevant and appropriate to both FAA-A1, FAA-B3, and the remainder of GWOU because of potential discharge of contaminated groundwater to surface water and to FAA-A1 due to discharge of treated water to surface water.

- *OAC 3745-1-03, Analytical Methods and Availability of Documents* specify analytical methods and collection procedures for surface water discharge. These criteria are relevant and appropriate to Alternative FAA-A1 because this selected remedy includes discharge of treated water to surface water.

- *OAC 3745-2-04 through –09, Development of Water Quality Based Effluent Limitations*, are used to determine waste load allocations for discharges to surface water, which impacts discharge limits. These regulations are considered applicable to FAA-A1 due to discharge for surface water.

- *OAC 3745-32-05, Water Quality Criteria for Decision by Director* specifies substantive criteria for Section 401, Water Quality Criteria for actions including altering waters of the state. These criteria are relevant and appropriate to FAA-A1 due to discharge to surface waters.

- *OAC 3745-38, NPDES Permit* covers discharges to state waters from area sources and storm water point sources and describes Notice of Intent (NOI) requirements. This regulation is relevant and appropriate to Alternative FAA-A1, which involves discharge to surface water.

Air

- *Clean Air Act, Section 112, List of Source Categories and Hazardous Pollutants to be Regulated* identifies categories of industrial facilities, which will emit substantial quantities of each air toxic.

- The document "Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites", establishes guidance on control of air emissions from air strippers used at Superfund sites. This guidance is to be considered for Alternative FAA-A1 groundwater treatment. This document also provides guidance regarding control of VOC emissions particularly in non-attainment areas for ozone and establishes procedures for implementation.

- *ORC 3734.02(I) and .05 (D)(6)(c), Air Emissions from Hazardous Waste Facilities*, prohibits emission of any particulate matter, dust, fumes, gas, mist, smoke, vapor, or odorous substances.

- *ORC 3704.05 (A – I), Air Pollution Control Rules* prohibits emissions of contaminants resulting from remedial actions.

- *OAC 3745-15-06 (A1, A2) and –07 (A), Air Pollution Control* establishes scheduled maintenance and specifies when pollution source must be shut down during maintenance. In addition, the regulation defines air pollution nuisance as the emission or escape into the air from any source.

- *OAC 3745-21-02 (A, B, C); -03 (B,C,D); -05 ; -07 (A, B, G, I, J); and –09 (DD), Ambient Air Quality Standards and Guidelines* establishes specific air quality standards for carbon monoxide, ozone, and non-methane hydrocarbons; specifies measurement methods; and requires best available technology.

These regulations are relevant and appropriate to Alternative FAA-A1 because air stripping operations are included. Emissions from these sources will be controlled and are not expected to be significant. However, WPAFB is, in its entirety, considered a "major source".

Groundwater

- The document *"Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites"* focuses on key issues in the development, evaluation, and selection of groundwater remedial actions at Superfund sites and is to be considered for both of the selected remedies.

- *OAC 3745-34 –06, Prohibition of Unauthorized Injection; -07, No Movement into Underground Drinking Water; and -13, Class V Wells* requires authorization for underground injection, prohibits injection of fluid containing contaminants into drinking water that exceeds MCLs, and specifies requirements for Class V wells. This ARAR is applicable to FAA-B3, which involves underground injection.

Hazardous Waste Management

- *40 CFR 262, Standards Applicable to Generators of Hazardous Waste* defines procedures for accumulation, reporting, and shipment of hazardous waste.

- *OAC 3745-52-11 (A – D); -20; 22; 23; -30 through –34, Generators of Hazardous Wastes* requires generators of hazardous waste to determine whether waste is hazardous and designate the facility (and an alternate) to receive hazardous waste.

- *OAC 3745-55-71 through –74, Management of Hazardous Wastes: Closure and Post-Closure* requires that containers holding hazardous waste be maintained in good condition and compatible with the waste. Also, this regulation describes requirements for managing and inspecting containers of hazardous waste.

These ARARs are relevant and appropriate for Alternative FAA-A1. Spent carbon from the carbon adsorption process may require disposal as a hazardous material.

- *40 CFR 264, Subparts O- I, X, AA – DD, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities* defines standards for construction and operation of on-site waste management facilities. Applicable to FAA-A1 because this alternative involves treatment of hazardous waste through treatment of groundwater,

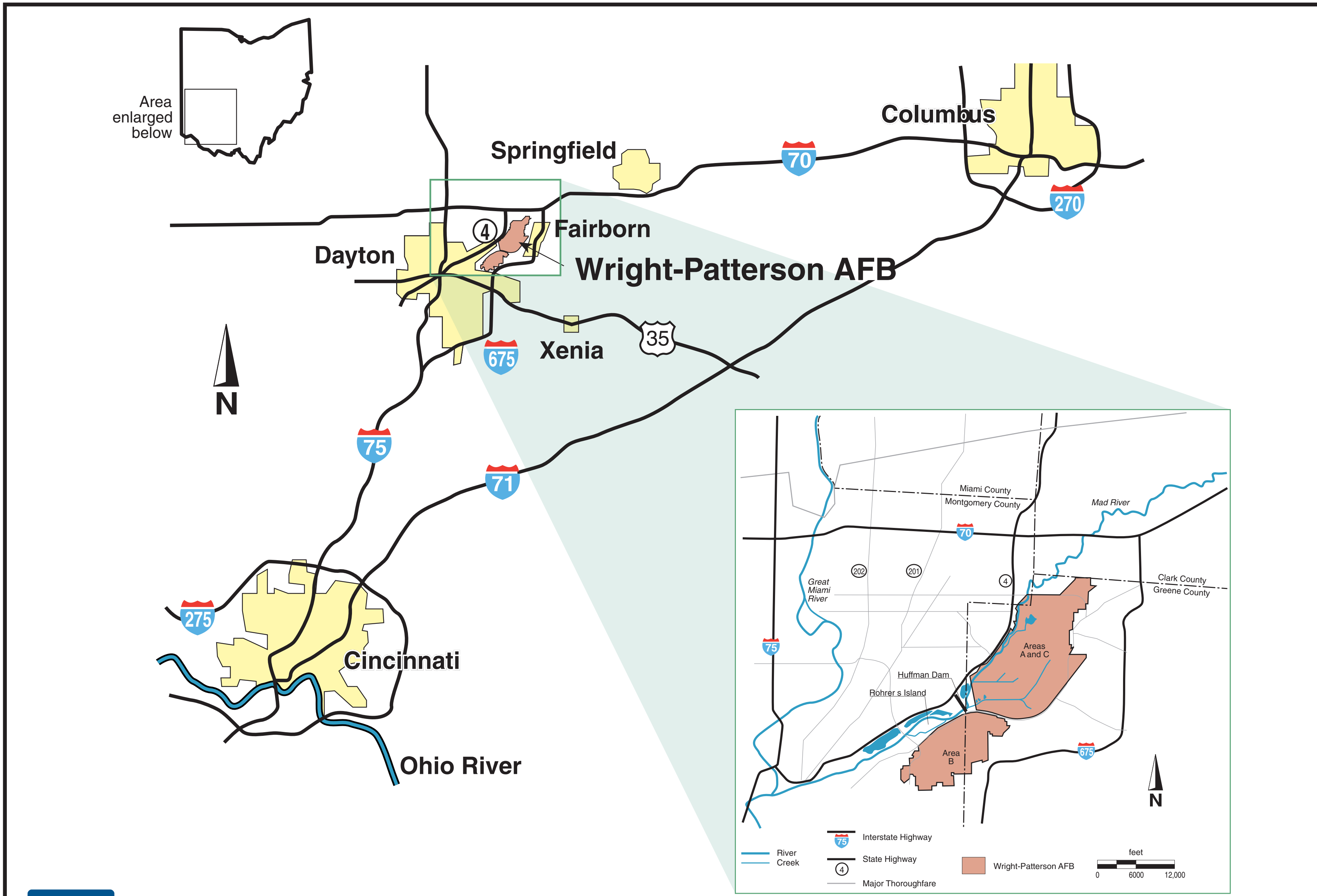
.

Table 3

Estimated Cost of Remedy for GWOU

	FAA-A1	FAA-B3	LTM [1]
Capital Cost	$ -	$ 341,040	--
Annual Operating Costs	$ 251,000	$ 9,500	$468,000
Total Cost for First Year of Operation	$ 251,000	$ 351,000	$468,000
Present Worth (30 years at 3%)	$ 4,920,000	$ 351,000	$ 9,173,000

([1]) Long-term monitoring as described in Attachment A for the remainder of the GWOU



IT CORPORATION

Figure 1. Area Location Map.

DRAWING BY	KMS	CHECKED BY			DRAWING NO.
	5/17/99	APPROVED BY			K-781791-0201-5/99-w

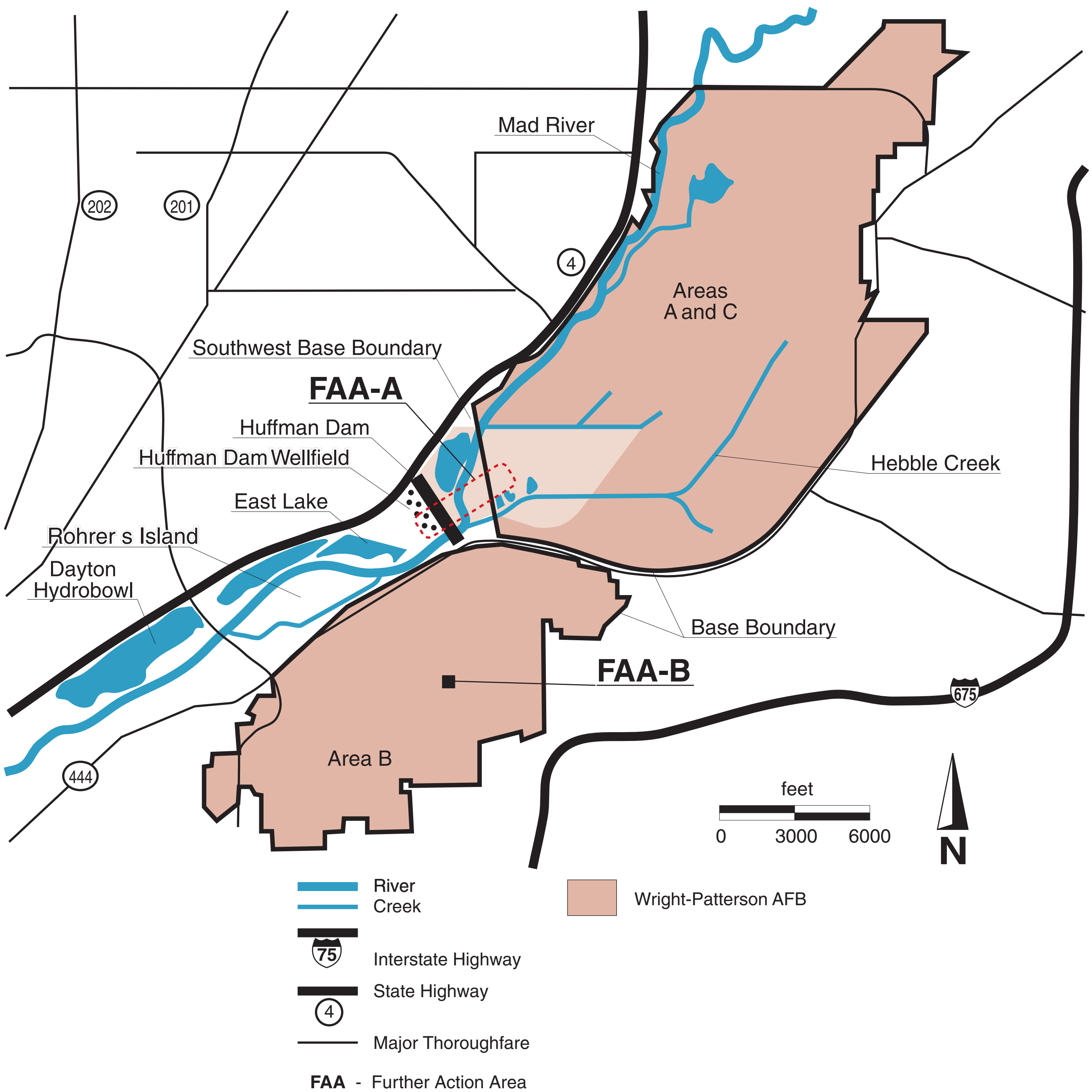


Figure 2. Site Location.

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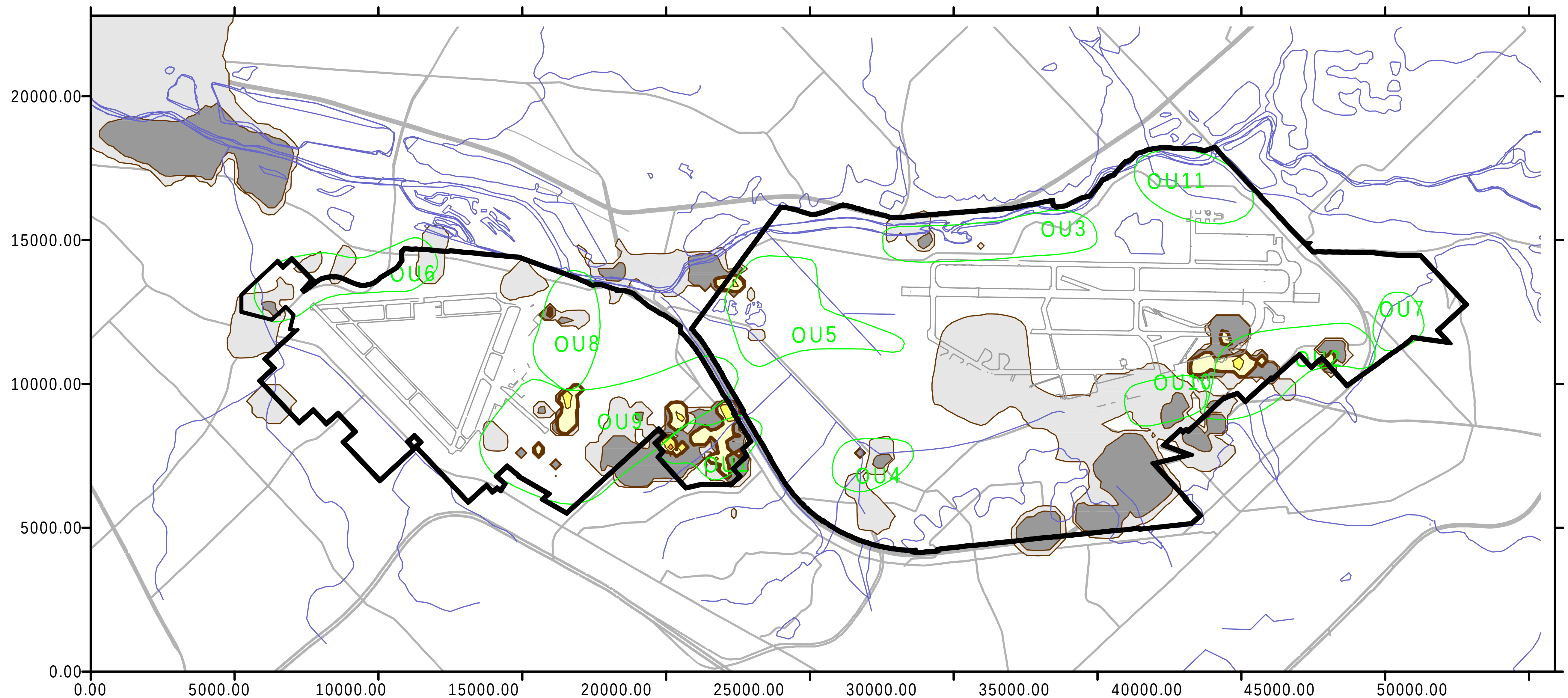
DRAWING BY KMS 7/13/99



LEGEND

Stream

Base Boundary

Roadways/Runways

Operable Unit (OU) Boundaries

Cancer Risk Contour Line
(Lifetime Cancer Risk)

COLOR SCALE

1E-006 1E-005 1E-004 1E-003 1E-002 1E-001

(Lifetime Cancer Risk Value)

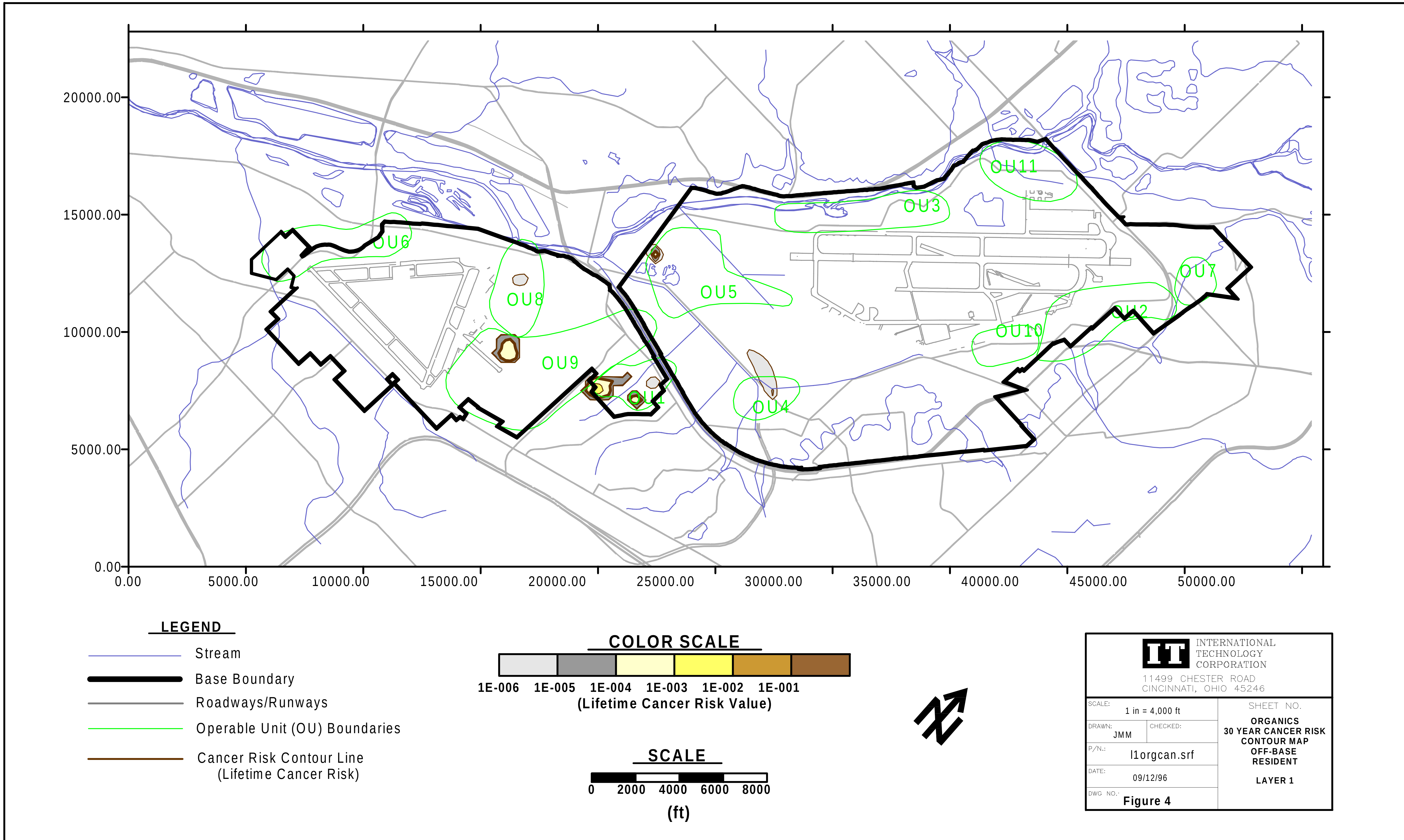
SCALE

0 2000 4000 6000 8000

(ft)

INTERNATIONAL TECHNOLOGY CORPORATION
11499 CHESTER ROAD
CINCINNATI, OHIO 45246

SCALE: 1 in = 4,000 ft	SHEET NO.
DRAWN: JMM / CHECKED:	CURRENT ORGANICS CANCER RISK CONTOUR MAP OFF-BASE RESIDENT
P/N.:	
DATE: 09/12/96	LAYER 1
DWG NO.: Figure 3	



20000.00
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35000.00
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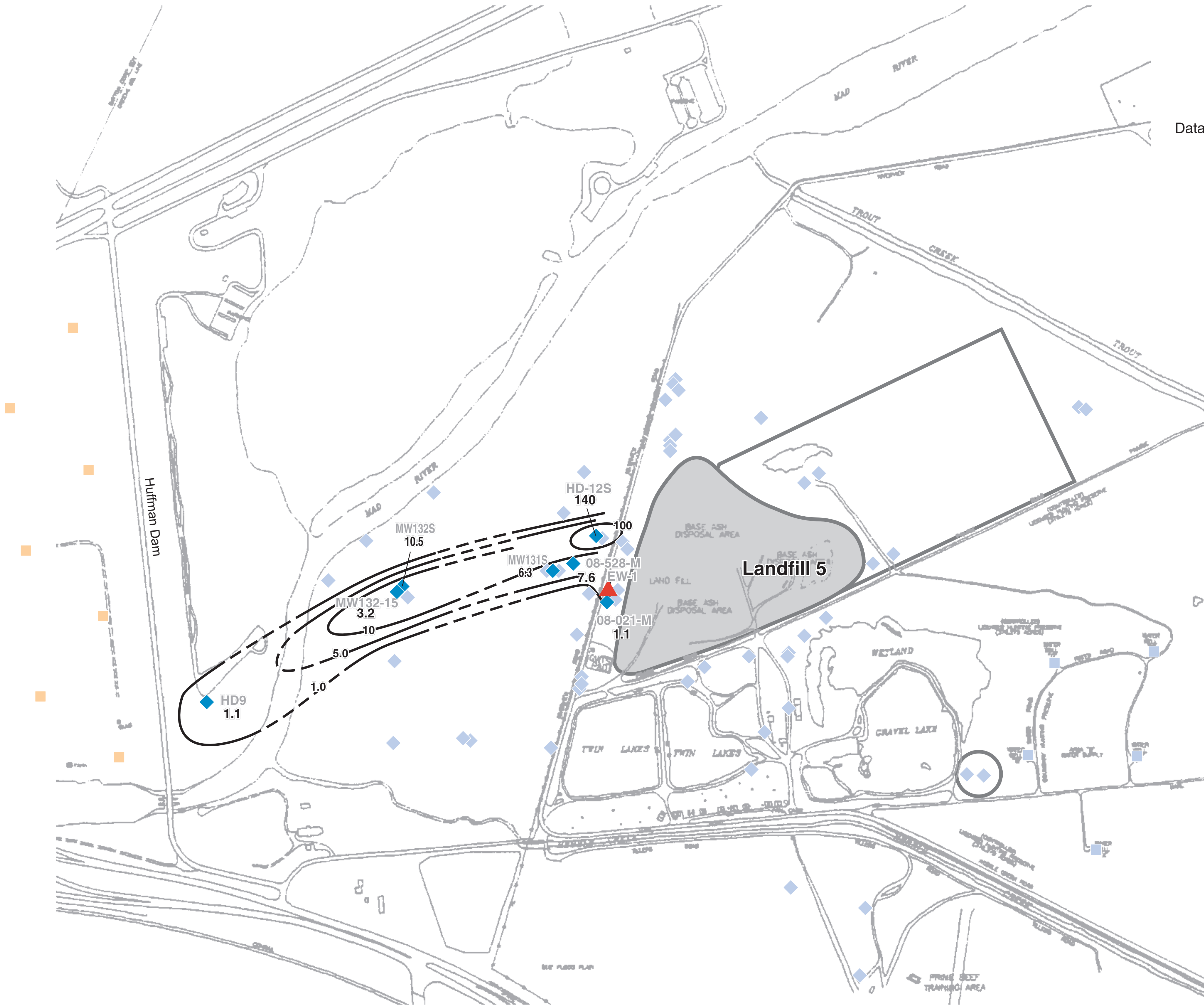
45000.00
50000.00
OU6
OU8
OU9
OU5
OU3
OU11
OU7
OU2
OU10
OU4
OU1
LEGEND
Stream
Base Boundary
Roadways/Runways
Operable Unit (OU) Boundaries
Cancer Risk Contour Line
(Lifetime Cancer Risk)
COLOR SCALE
1E-006 1E-005 1E-004 1E-003 1E-002 1E-001
(Lifetime Cancer Risk Value)
SCALE
0 2000 4000 6000 8000
(ft)
N
INTERNATIONAL TECHNOLOGY CORPORATION
11499 CHESTER ROAD
CINCINNATI, OHIO 45246
SCALE: 1 in = 4,000 ft
DRAWN: JMM
CHECKED:
P/N.: l1orgcan.srf
DATE: 09/12/96
DWG NO.: Figure 4
SHEET NO.
ORGANICS
30 YEAR CANCER RISK
CONTOUR MAP
OFF-BASE
RESIDENT
LAYER 1



Monitoring Well, compound detected (g/L)

Monitoring Well, compound not detected

Base Supply Well

City of Dayton Suply Well

OU5 Extraction Well

Data Sources: R.I. Round 2 Groundwater Sampling, Feb. 14 Mar. 7, 1994

1st qtr. RASPR Groundwater Sampling, Feb. 14 Mar. 7, 1994

Water Road Base Supply Well Groundwater Sampling, Feb. 25 and April 6, 1994

10 PCE Concentration Isopleth (ppb, dashed where inferred)

IRP Sites

Note: PCE not detected in wells unless otherwise specified.

N

feet

0 300 600

Figure 5.
PCE Concentration (g/L)
in Groundwater,
February April 1994.

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APPROVED BY

JJG, III

9/11/97

DRAWING BY

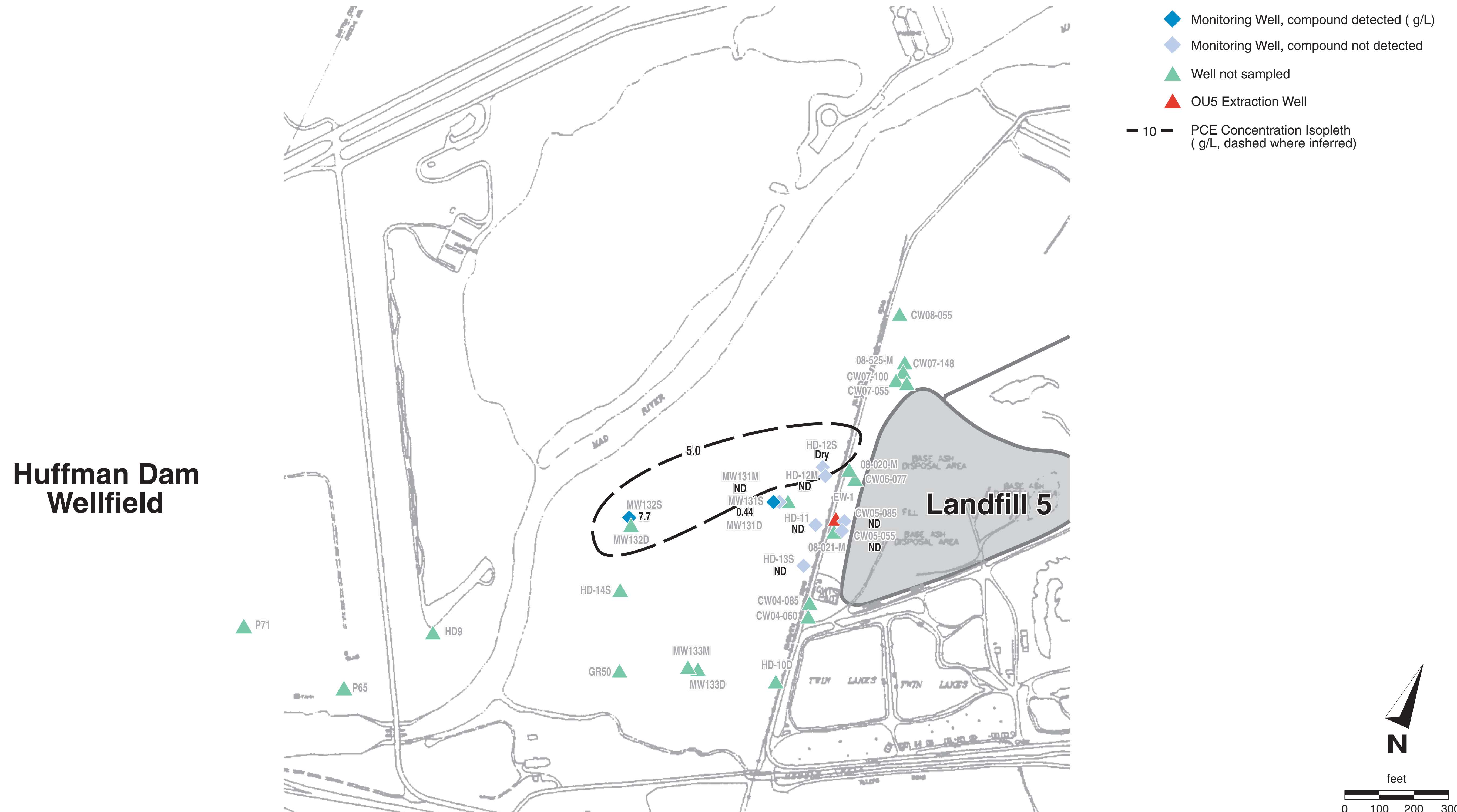

Figure 6.
PCE Concentration
in Groundwater
Further Action Area A,
April 1999.

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S-762297.0602-7/99-4w

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APPROVED BY
JJS, III
7/21/99
DRAWING BY

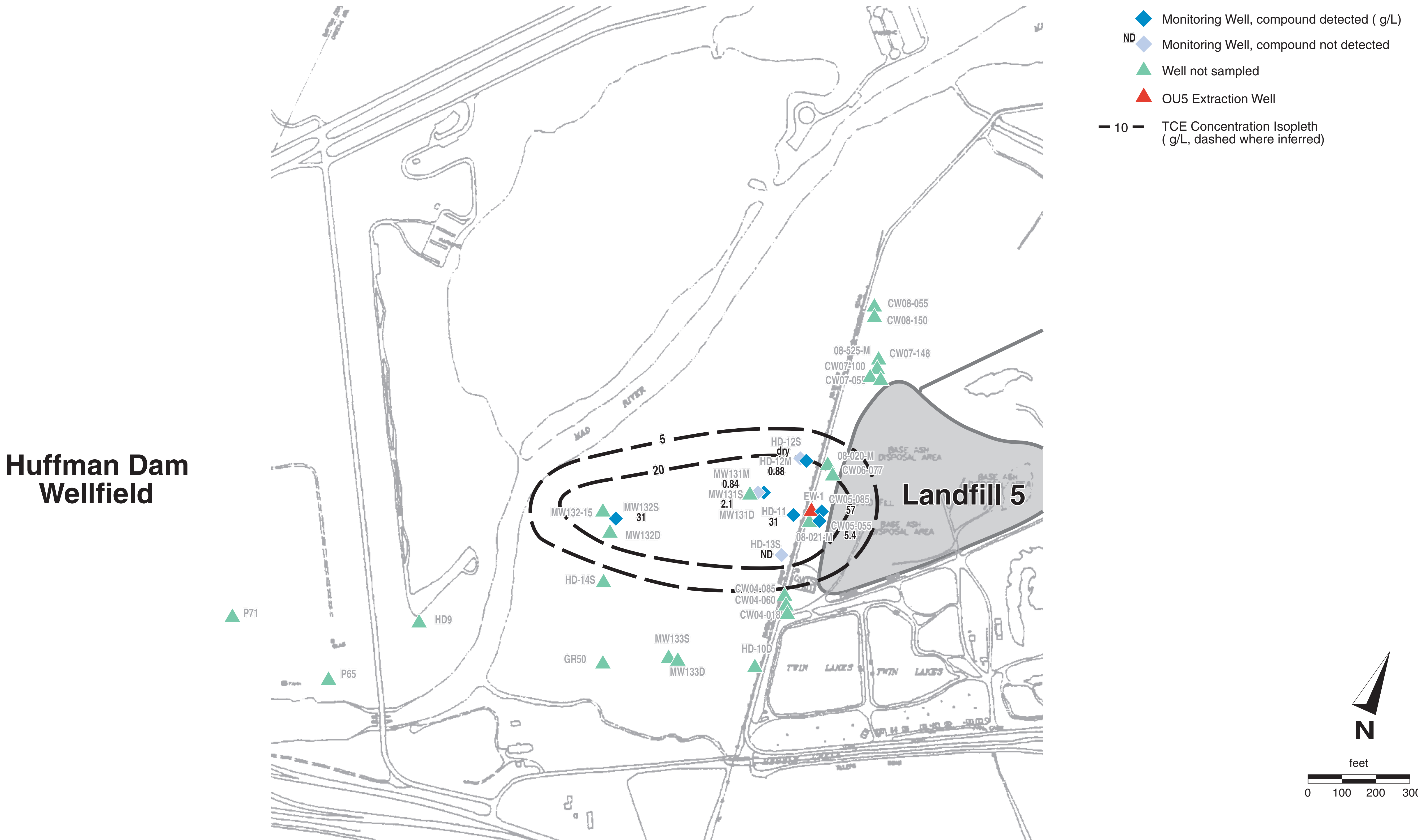


Figure 7.
TCE Concentration
in Groundwater
Further Action Area A,
April 1999.

DRAWING NO. S-762297.0602-7/99-5w

CHECKED BY

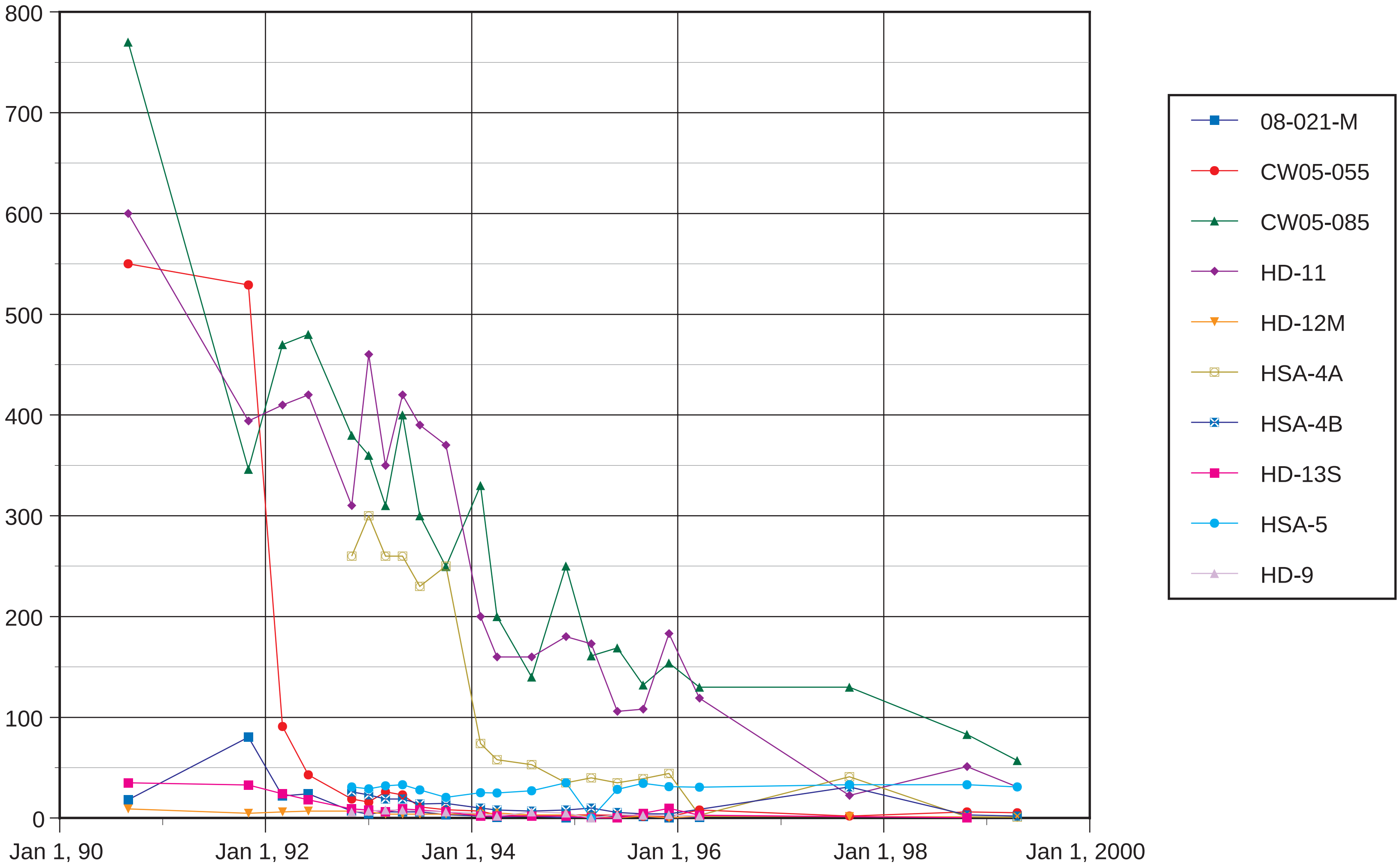
APPROVED BY

JIS, III

7/21/99

DRAWING BY

IT CORPORATION



IT CORPORATION

Figure 8.
TCE in Selected Wells as a Function of Time.

DRAWING BY	JIS, III	CHECKED BY			DRAWING NO.
	7/27/99	APPROVED BY			S-762297.0602-7/99-6w

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CHECKED BY JM
APPROVED BY 9/23/99
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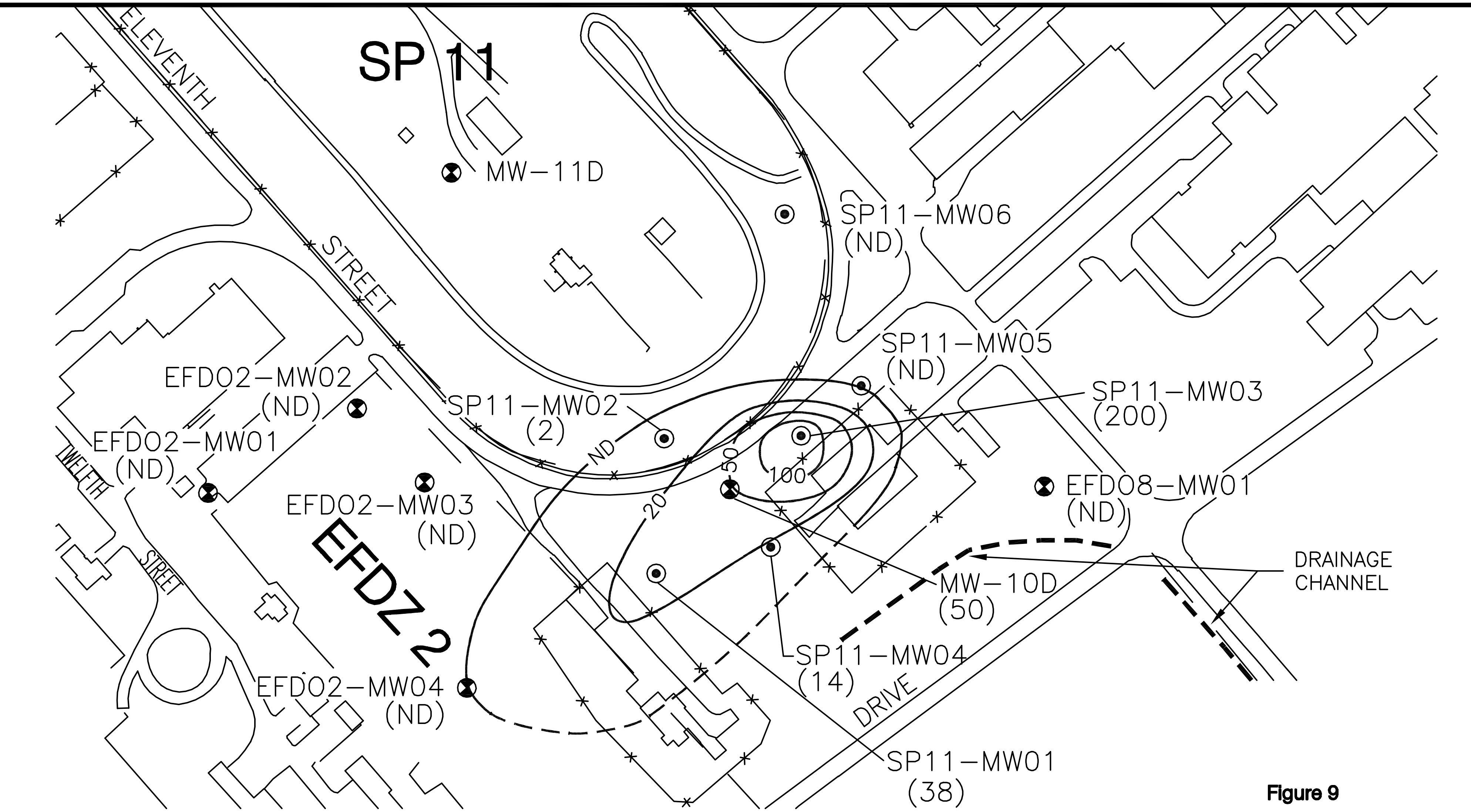

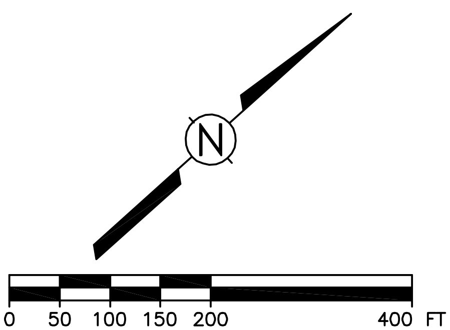

LEGEND:

- NEW MONITORING WELL LOCATION
- EXISTING MONITORING WELL
- (50) VINYL CHLORIDE GROUNDWATER CONCENTRATIONS (μg/L)
- —10— VINYL CHLORIDE CONCENTRATION ISOPLETH (μg/L) (DASHED WHERE INFERRED)
- (ND) NOT DETECTED

Figure 9

VINYL CHLORIDE GROUNDWATER CONCENTRATIONS ISOPLETH MAP FAA-B

WPAFB - BMP

INTERNATIONAL TECHNOLOGY CORPORATION

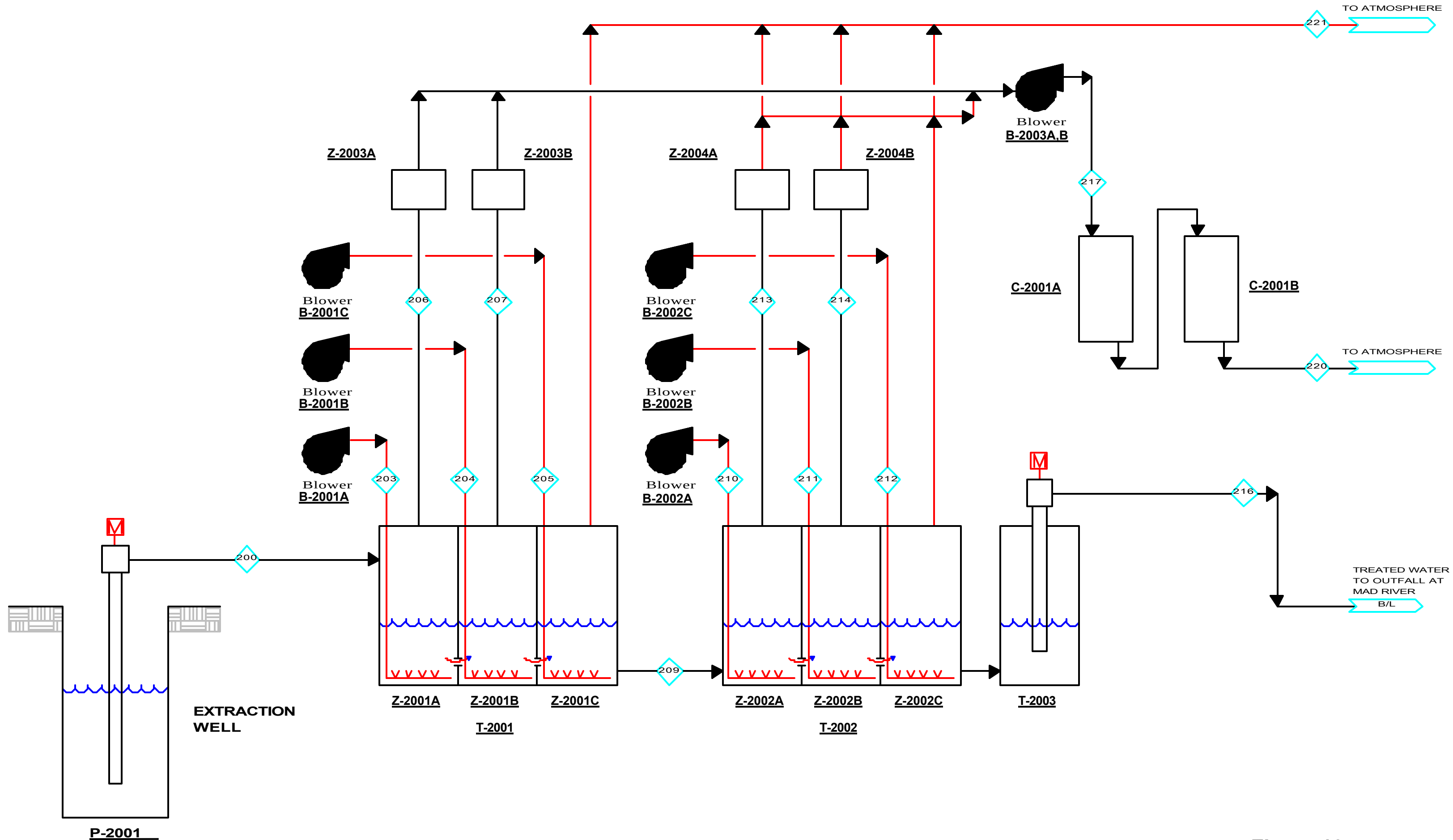

Figure 10

P-2001
EXTRACTION WELL

P-2001A-C
PRIMARY AERATION BLOWER

Z-2001A-C
PRIMARY DIFFUSER

T-2001
PRIMARY AERATION TANK (STAGES 1-3)

Z-2003A,B
PRIMARY DEMISTER

B-2002A-C
SECONDARY AERATION BLOWER

Z-2002A-C
SECONDARY DIFFUSER

T-2002
SECONDARY AERATION TANK (STAGES 4-6)

Z-2004A,B
SECONDARY DEMISTER

B-2003A,B
EXHAUST BLOWER

C-2001A,B
VAPOR-PHASE CARBON ADSORBER

T-2003
DEGAS TANK

P-2003A,B
TREATED WATER DISCHARGE PUMP

INTERNATIONAL
TECHNOLOGY
CORPORATION

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Attachment 1

Groundwater Operable Unit Monitoring Plan

ATTACHMENT 1 - GROUNDWATER MONITORING PLAN

A.1 Introduction

This attachment presents the long-term monitoring (LTM) program for the Groundwater Operable Unit (GWOU) at Wright-Patterson Air Force Base (WPAFB). The rationale for selection of monitoring locations is presented, followed by the recommended monitoring frequency, duration of monitoring, and data evaluation procedures. This plan is the basis for monitoring that will be conducted prior to and after finalization of the Record of Decision (ROD) for the GWOU. Data collected from this monitoring program will be reviewed after each monitoring period (and at 5-year intervals) to determine if changes to the plan are necessary. Should WPAFB determine that changes are necessary or appropriate, WPAFB will propose these changes to USEPA and OEPA for approval prior to initiating any sampling reductions. Depending on the scope of the proposed changes, the plan may be revised by an addendum outlining change or a revised plan may be issued. All plan changes are subject to the review and approval of the USEPA and Ohio EPA. These program changes will be described in the semi-annual reporting to be provided under the LTM program. Results of sampling modifications will be presented in the semi-annual report.

The goal of the GWOU monitoring plan is to provide ongoing confirmation in support of the decisions presented in the final ROD for the GWOU. Specifically, the objectives of the GWOU monitoring plan are:

- Provide data to monitor past detections above the Maximum Contaminant Levels (MCLs) of inorganic Constituents of Potential Concern (COPC) at WPAFB that do not appear to form congruent contaminant plumes.
- Provide data to monitor areas of groundwater at WPAFB that exceed MCLs for Volatile Organic Compounds (VOCs), but indicate incremental risk to residential receptors within the target risk range.
- Provide data to monitor areas of groundwater that exceed the target risk range.
- Provide monitoring to verify progress of ongoing remedial efforts in accordance with the RODs at Operable Unit (OU) 1 and OU2.

- Provide monitoring data in accordance with the recommended action for Further Action Area A (FAA-A) (OU5 off-site plume) to evaluate the progress of the selected remedy (this monitoring to take the place of that being conducted to monitor the current groundwater removal action).

- Provide monitoring data in accordance with the recommended action for FAA-B (vinyl chloride site east of Spill Site 11 [SP11]) to evaluate progress of the selected remedy.

- Provide monitoring data to determine whether natural attenuation processes have reduced VOC concentrations since initial Remedial Investigation data was collected. This monitoring will be conducted at locations which are not associated with existing remedial actions or with remedial actions specified in the GWOU ROD.

A.2 Selection of Monitoring Locations

Information used to identify long-term monitoring locations included the analysis presented in Section 5.0 of the EE/CA for identifying FAAs, the BMP groundwater flow and transport models, the OU1 Final Operations and Maintenance Plan-Part 4, the BMP Site Specific Work Plan Addendum No. 2 for evaluation of OU2, and the Groundwater Treatment System program at OU5. The monitoring well locations are depicted in Figure A-1. Monitoring locations are discussed as follows:

- Locations with existing remedial actions
- Locations exceeding MCLs and target risk levels
- Locations with organic COPCs exceeding MCLs
- Locations with organic COPCs exceeding target risk levels
- Locations with inorganic COPCs exceeding background and MCLs.

Areas with Existing Remedies in Place

<u>OU1</u>

The Operations and Maintenance Plan (Kelchner, 1997) prepared for the implementation of Landfills 8 and 10 Source Control Operable Unit (SCOU) Remedial Action contains a groundwater quality monitoring program as defined in the OU1 SCOU ROD (WPAFB, 1993). The groundwater monitoring program documented in that plan is included in the GWOU monitoring plan without modification. Analytical parameters at OU1 include VOCs, SVOCs, dioxin/furans, pesticides/ PCBs, metals, and mercury/cyanide. The monitored wells are presented in Table A-1.

<u>OU2</u>

A ROD for OU2 is in place that calls for monitoring natural attenuation of benzene, toluene, ethylbenzene, and toluene (BTEX) contamination, continued operation and maintenance of the existing product removal system, institutional controls, and monitoring. The BTEX plume at OU2 is currently being monitored in accordance with the BMP Site Specific Work Plan Addendum No. 2 to monitor the natural attenuation progress of the dissolved-phase petroleum hydrocarbons. Based on results of a Baseline sampling event and ongoing LTM sampling, a network of 13 wells is being utilized for long-term monitoring. This monitoring program is included in the GWOU monitoring network without modification. Analytical parameters include BTEX compounds and the following natural attenuation parameters: methane, ethane, ethene, nitrates, sulfate, dissolved oxygen, and ferrous iron. The monitored wells are presented in Table A-1.

Areas Exceeding MCLs and Risk Action Levels

<u>FAA-A</u>

A groundwater treatment system at Landfill 5 has been operating since December 1991. The monitoring program previously included quarterly monitoring of up to 26 wells. A review of the monitoring data collected through February 1997 indicated that the extraction well (EW-1) effectively controls source migration. Of the 26 wells monitored in the February sampling event, VOCs were either not detected or were detected significantly below the MCL in 17 wells. These 17 wells have been removed from the GWOU monitoring network. The remaining nine monitoring locations are presented in Table A-1. Analytical parameters for the OU5 off-site samples include Target Compound List (TCL) VOCs.

<u>FAA-B</u>

The recommended alternative in the EE/CA for the area east of SP11 is in-situ oxidation. The three wells within the plume with the highest detected concentrations (SP11-MW01, SP11-MW03, OU8-MW10D) and the well down gradient (SP11-MW02) were selected for monitoring the vinyl chloride plume. Additional wells, which will be installed as a part of the removal action for FAA-B (in-situ chemical oxidation tests) may also be monitored depending on the results of the removal action. Any changes in the monitoring plan will be approved by the USEPA and OEPA. Samples from these wells will be analyzed for TCL volatile organics.

Areas Exceeding MCLs for Organic COPCs

Organic COPC contamination exceeded MCLs, but within the target risk range were presented in the GWOU EE/CA. COPCs included TCE, PCE, benzene, bis(2-ethylhexyl)phthalate (BEHP), vinyl chloride, and 4,4'-DDT. The frequency of detection of 4,4'-DDT was approximately 1%. Due to this low detection frequency, 4,4'-DDT is not included in the GWOU monitoring program.

The detection frequency of BEHP above the MCL in aquifer Layers 1, 2, and 3 was 4, 3, and 4.9%, respectively. A review of historical data from the wells impacted by BEHP indicates that BEHP is typically not detected or detected below the MCL in at least one sample from each well. Due to the low frequency of detection and the lack of persistence of BEHP at concentrations above the MCL, locations impacted only by BEHP are not included in the GWOU monitoring program.

Selected wells from remaining areas impacted by TCE, PCE, benzene, and vinyl chloride are included in the GWOU monitoring program. The objective of including these areas is to assess contaminant migration and to evaluate concentration changes over time. Identification of wells to include in the GWOU network was accomplished by reviewing concentration data in conjunction with the projected groundwater flowpaths presented in the BMP Groundwater Flow Model Technical Memorandum and the projected plume migration paths presented in the BMP Transport Modeling Technical Memorandum.

Wells were selected that provide a comprehensive evaluation of contaminant migration from impacted wells and that will also detect potential off-Base migration. At areas containing several impacted wells, an effort was made to identify the minimum number of wells which would achieve the monitoring program objectives. Some impacted wells were not included in the GWOU network based on proximity (laterally and vertically) to other impacted wells along the projected flowpath. In these instances, the wells exhibiting the highest detected concentrations were included in the monitoring network. The wells retained for the GWOU network are presented in Table A-1 and Figure A-1.

Two additional wells were installed in October 1998 to provide monitoring locations downgradient of documented TCE and vinyl chloride contamination at OU4. Well BMP-OU4-

01B-6D is screened in Layer 2 and well BMP-01C-84 is screened in Layer 3. Samples from these wells have been analyzed for TCL VOCs and results are presented in the semi-annual reports.

Areas Exceeding Target Risk Levels

All areas exceeding a 10^{-4} cumulative cancer risk and/or cumulative hazard index of 1 will be monitored either as part of existing remedial actions or through proposed remedial actions for FAA-A and FAA-B. One exception is in the vicinity of Landfill 11. This area of risk exceedance is due to a cumulative hazard index greater than 1, and is based on analytical results from leachate wells. Landfill 11 has been capped and the leachate wells have been abandoned. Monitoring of this area will be accomplished through semi-annual sampling of well 07-520-M, which is hydraulically downgradient of the impacted area. The well will be sampled for VOCs and total and filtered metals.

Areas Exceeding MCLs and Background for Inorganic COPCs

As discussed in the ROD, inorganic contamination in groundwater is not considered widespread or persistent. The objective for inorganic sampling during the GWOU monitoring is to:

1) assess local geochemical conditions which may contribute to dissolved phase inorganic chemicals,
2) assess the effect of suspended solids on inorganic analytical results, and
3) monitor to assess whether the inorganic COPCs are migrating.

Wells included in the GWOU network were limited to those which exhibited concentrations in excess of MCLs and background for at least three inorganic COPCs. Table A-1 lists the 20 wells which met this screening criteria. These wells will be sampled for filtered and unfiltered TAL metals. Field parameters (temperature, pH, conductivity, dissolved oxygen, and redox potential) will also be collected to support geochemical analysis. Two of these wells OU10-MW-06S and WP-NEA-MW20-2S, are also being monitored for organic COPCs. Once repaired, well OU10-MW-03s will also be monitored for both organic and inorganic COPCs.

A.3 Monitoring Frequency

The monitoring frequency for each sample location is a function of the location within the study area (hill or outwash) and the class of COPC to be monitored.

Results of the groundwater flow and transport modeling indicated that contaminant migration in the "hill" portion of the aquifer is minimal due to the low hydraulic conductivity of the dense silts and clays which comprise the aquifer. For this reason, sample locations within the "hill" portion of the aquifer are recommended for annual monitoring as indicated in Table A-1. One exception is at FAA-B, where semi-annual monitoring will be completed to evaluate in-situ oxidation performance.

The projected rate of transport of inorganic COPCs is very low in both the hill and outwash portions of the aquifer, as demonstrated in the Groundwater Contaminant Transport Technical Memorandum. Therefore, it is recommended that sampling of wells for analysis of metals concentrations in groundwater be conducted on an annual basis. Because of the relatively higher rate of VOC mobility indicated in the Contaminant Transport Technical Memorandum, wells screened in the outwash to be sampled for organic COPCs will be sampled on a semi-annual basis.

A.4 Data Evaluation / Monitoring Duration

OU1

Data collected from wells associated with OU1 will be evaluated and reported in accordance with requirements specified in the OU1 Source Control Operable Unit ROD. The OU1 monitoring program will continue for a period of 5 years after cessation of groundwater extraction, or until 30 years after implementation of the remedial action, whichever is later.

OU2

Data collected from wells associated with natural attenuation monitoring of the BTEX plume at OU2 will be evaluated in accordance with procedures documented in the BMP Site Specific Work Plan Addendum 2. Based on results of site-specific modeling conducted during the OU2 feasibility study, it is projected that the BTEX plume will diminish to levels below action levels after approximately 11 years.

Data from the initial 5-year monitoring period are currently being evaluated to verify that natural attenuation processes are reducing contaminant concentrations. If contaminant concentrations do not decrease as anticipated, other remedial alternatives may need to be evaluated.

FAA-A

Data associated with the OU5 off-site remedial action will be evaluated to determine whether remedial action objectives are being met. This data evaluation will include an assessment of the decrease in concentrations of organic COPCs at the OU5 groundwater treatment system influent and in the plume.

FAA-B

Wells associated with FAA-B will be sampled for VOCs on a semi-annual basis for a one-year period. The sampling events will commence approximately 6 months after the recommended alternative (in-situ oxidation) has been implemented and has reduced contaminant concentrations below remedial action objectives. If contaminant concentrations remain below the remedial action objectives after the conclusion of one year, monitoring at FAA-B will cease. Otherwise, monitoring will continue until such time as the organic COPCs achieve MCLs.

Areas having Organic COPCs above MCL but Within Target Risk Range

VOC data will be collected from wells monitored for organic COPCs for a period of 5 years. The data will be evaluated in preparation for the 5 year program review milestone specified in the National Contingency Plan (NCP). Evaluation will consist of reviewing concentration vs. time graphs for obvious trends, e.g., all sample results below action levels, which would substantiate termination of long-term monitoring at individual locations. Statistical analysis may also be used to determine whether there exists statistically significant evidence of contamination exceeding action levels. Results of the statistical analysis will also be used to substantiate elimination of individual wells from the monitoring network. Locations which cannot be eliminated based on the data evaluation will be retained for further monitoring.

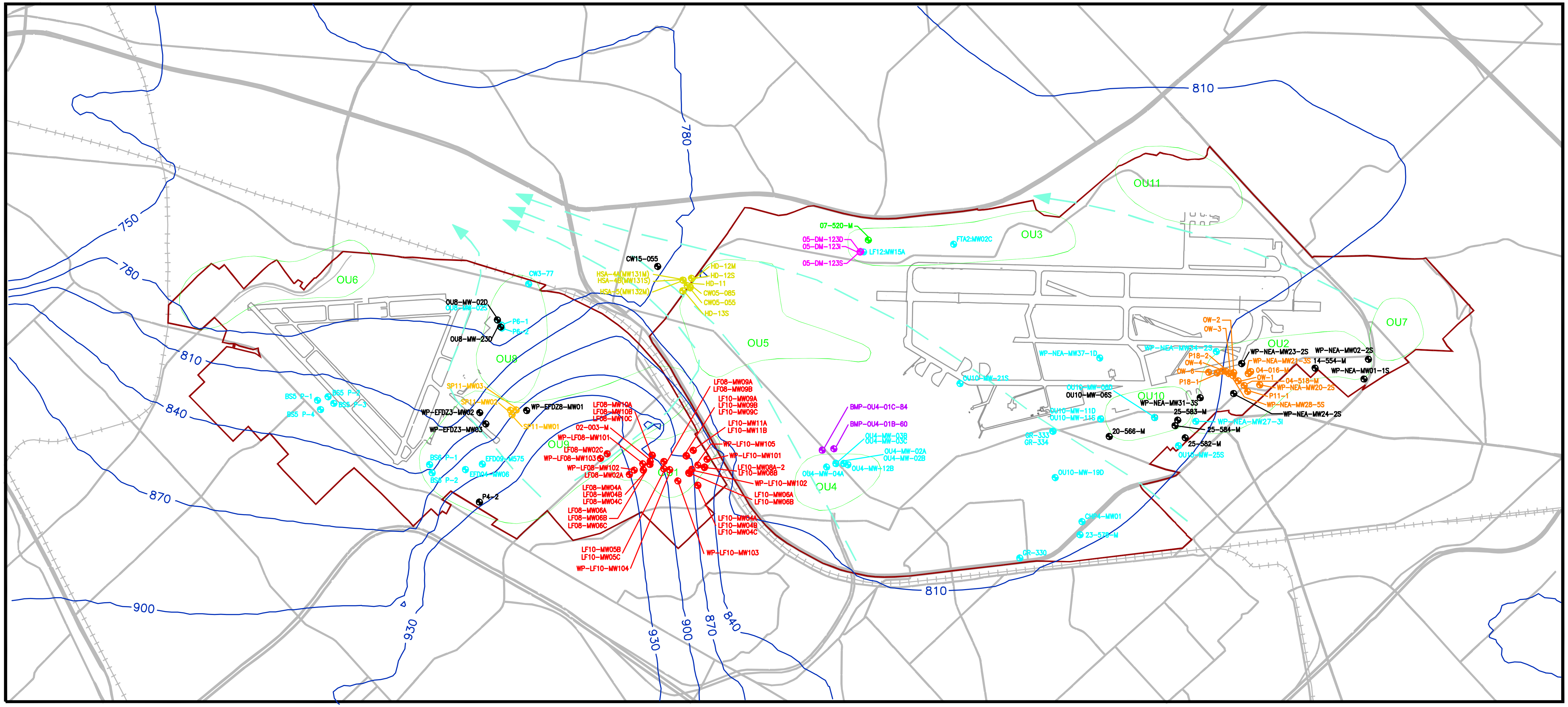
Areas having Inorganic COPCs above MCL

Inorganic analytical data be collected for an initial period of 5 years. Concentration vs. time graphs of these data will be reviewed for obvious trends, and statistical analysis will be conducted to determine whether there is statistically significant evidence of contamination exceeding action levels. Locations where the data indicate that inorganic COPC concentrations are below action levels will be eliminated from the monitoring network after 5 years of monitoring data.

Filtered and unfiltered metals samples will be collected during the BMP. Filtering will be accomplished using a 2-micron filter. The purpose of filtering is to remove coarser particles from the nearwell environment rather than remove colloids. Data from filtered samples from locations that exhibit significant concentrations exceeding action levels will be reviewed and compared to data from unfiltered samples to determine whether there is conclusive evidence that elevated concentrations of inorganic COPCs can be attributed to solid phase inorganics adsorbed onto suspended particles. Locations where this phenomenon exist will be eliminated from the monitoring network.

If an inorganic sample location cannot be eliminated after the first two evaluation steps, field parameter data (pH, conductivity, dissolved oxygen, and redox potential) will be evaluated to determine whether elevated concentrations are due to naturally occurring geochemical processes. Locations where elevated concentrations can be attributed to naturally occurring processes will be eliminated from the monitoring network.

It is anticipated that all locations sampled for inorganic COPCs (except for wells monitored in accordance with the OU1 SCOU ROD) will be eliminated from the monitoring network after the three-phase data evaluation is complete.   However, locations which cannot be eliminated based on the data evaluation will be retained for additional monitoring.



LEGEND:

- Wells Associated with OU1 Remedial Action
- Wells Associated with OU2 Natural Attenuation Monitoring
- Wells Associated with OU5 Off-Site Plume Monitoring
- Wells Monitored for Inorganics only
- Wells Associated with Monitoring Area East of Sp11
- Wells Monitored for Volatile Organics only
- Proposed New Monitoring Location
- Well Associated with Area Exceeding Target Risk
- Wells Associated with LF12 Removal Action

- Base Boundary
- Roadways/Runways
- Operable Unit (OU) Boundaries
- Generalized Groundwater Flow Lines
- Groundwater Elevation Contours

N

0 1750 3500 7000 FEET

Figure A-1

GWOU Long Term Monitoring Network

INTERNATIONAL TECHNOLOGY CORPORATION

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